5.1.2-3

WORK PLAN
WELL INSPECTION, TESTING AND INSTALLATION PROGRAM IN SUPPORT OF GROUNDWATER EXTRACTION SYSTEM DESIGN

SIMPLOT PLANT AREA
Eastern Michaud Flats Superfund Site

September 17, 2002

MFG, Inc.
consulting scientists and engineers

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SIMPLOT PLANT AREA
Eastern Michaud Flats Superfund Site

September 17, 2002

Prepared for:

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MFG Project No. 010121-1

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1.0 INTRODUCTION

The draft Remedial Design Report (RDR) for the Groundwater Extraction System at the Simplot Plant Area of the Eastern Michaud Flats Superfund Site was submitted to the U.S. Environmental Protection Agency Region 10 on August 5, 2002 (MFG, 2002). The draft RDR identified the following field activities to support prefinal design of the extraction system:

- Inspection and testing of existing extraction wells 401 and 410, and
- Drilling a pilot boring and installation and testing of an additional extraction well in the West Plant Area (well 402).

This Work Plan presents the scope of work for the field investigation and inspection. In addition, the Plan includes two additional pilot borings, one at the proposed location of the lower zone extraction well in the East Plant Area and one west of monitoring wells 315 and 316.

The field investigation results will be included in the Pre-Final RDR, which must be submitted within 90 days after receiving Agency comments on the draft RDR document. It is planned to begin the field work the week of October 14, 2002.

2.0 BACKGROUND AND OBJECTIVES

2.1 Background

Numerical groundwater modeling was initially performed during the Feasibility Study (FS) to identify candidate groundwater extraction areas and conceptual pumping rates for capture, to the extent practicable, of groundwater affected by gypsum stack seepage (MFG, 1997). Subsequent to the FS, field studies and pilot tests were performed to further evaluate the candidate extraction areas and assess if the identified pumping scenarios would hold true under active pumping. Results from these studies and pump tests were evaluated and used to develop the detailed groundwater capture and extraction strategy described in the draft RDR for the Groundwater Extraction System (MFG, 2002). Details of this process are discussed in Appendix B to the RDR report.

2.2 Objectives

The objectives of the work described herein are to provide additional field data in preparation for the prefinal design. The specific objectives are as follows:

1. Conduct inspections and additional testing of wells 401 (formerly 343) and 410 (formerly 337) to assess their current condition and confirm their utility as long-term extraction wells. Inspect upper zone test extraction well 338, which will not be part of the extraction well network, to develop design criteria for the new upper zone extraction wells.

2. Complete test borings at three locations to provide data for extraction well location and design. The boring locations are as follows:

    - New extraction well 402 location in the West Plant Area;
    - Proposed location of new lower zone extraction well 411 in the East Plant Area; and
    - Area west of monitoring wells 315 and 316 to evaluate the saturated thickness of lower zone at the eastern edge of the bedrock knob

3. Complete one additional extraction well (402) in the West Plant Area to supplement existing extraction well 401.

4. Conduct a pumping test at well 402 to evaluate the well's ability to capture gypstack-affected groundwater and assess if installation of a third well in the West Plant Area will be necessary.

3.0 SCOPE OF WORK

The following tasks outline the work to be performed in support of the prefinal design of the groundwater extraction system. Relevant MFG Standard Operating Procedures (SOPs) will be followed in conducting this work (see Appendix A).

3.1 Task 1 - Inspections and Testing of Existing Extraction Wells

This task will involve inspection and repair/maintenance for wells 410 (formerly 337), 338 and 401 (formerly 343) (see table below). The specific work elements are as follows:

- Inspection and repair/maintenance of the currently installed pumps and down hole piping according to the inspection procedures checklists provided in Appendix B.
- Collection and analysis of scale and/or biomass samples (if present) from the pump and piping.
- Inspection, testing, and repair/maintenance of valves and electrical components (see Appendix B).
- Video camera survey of the well screens.

Well No.	Total Depth (ft. below ground	Screened Interval (ft below ground)	Approx. Depth to Water (ft below ground)
410	163	120-160	64.5
338	83	60-80	67.9
401	208	175-205	153.6
402 (new – not yet completed)	190 (estimated)	150-190 (estimated)	146 (estimated)

The logs and well completion information for wells 410 (337), 338 and 401 (343) are presented in the draft RDR. This task also includes the following elements, the scope of which will be more accurately defined following the well inspections:

<u>Well 410</u>

- If indicated by inspection program, implement rehabilitation measures to restore productivity of well 410. These measures may include one or all of the following: acid wash with surging to clear scale and remove silt, chlorination to kill biomass, additional development by pumping, jetting, bailing and/or surging and swabbing.

- Re-install the pump and test operation.
- Conduct pumping test (plus recovery) of well 410 after implementing rehabilitation measures to assess potential sustained yield. The test will consist of a minimum 8 hours pumping followed by water level measurements until levels have recovered to 90% of static water levels. Water levels will be monitored using pressure transducers in the pumping well and observation well 344. Water produced during the pump test will be directed to the plant cooling towers via existing or new piping systems.

Well 338

- Do not re-install the pump in well 338. This well will not be used as part of the extraction system.

Well 401

- If indicated by inspection program, implement rehabilitation measures to restore productivity of well 401. These measures may include one or all of the following: acid wash with surging to clear scale and remove silt, chlorination to kill biomass, additional development by pumping, jetting, bailing and/or surging and swabbing.
- Re-install the pump and test operation.
- Run short-term step test to assess well performance, particularly the ability of the well to sustain the original yield of 70 gpm.

The results of the inspections will be summarized and included in the Prefinal RDR.

3.2 Task 2 - Test Borings for Proposed Extraction Wells

Test borings will be completed at the proposed locations of extraction well 402 (near monitoring well 308) and extraction well 411 (approximately 400 feet east of well 337 and completed in the lower zone). The purpose of these borings is to collect core samples of the target well completion zone for sieve analyses by American Society of Testing and Materials (ASTM) D422. It is anticipated that samples will be collected at approximately five-foot intervals from the recovered cores within the target completion zones for sieve analysis. The sieve results will be used in the design of the well screen and filter pack. The borings will be completed using the rotosonic drilling technique, which will obtain six-inch diameter cores of the target completion zone material. The estimated depths of the pilot borings for 402 and 411 are 190 and 170 feet, respectively. The boreholes will be plugged with hydrated bentonite chips. If field conditions and sieve analyses indicate that the location of well 402 is not suitable for placement of an extraction well, one or more alternate locations will be selected for evaluation by test borings.

One additional boring will be completed using the same methods to evaluate the shallow aquifer west of monitoring wells 315 and 316 in the East Plant Area. This boring is necessary to evaluate the saturated thickness of the shallow aquifer at the eastern edge of the bedrock knob separating the West Plant Area (joint fenceline area) from the East Plant Area. The estimated depth of this boring is 85 feet. The information collected from this boring will be used to establish the appropriate location (and number) of shallow aquifer extraction wells in the East Plant Area.

3.3 Task 3 - Completion and Development of Extraction Well 402

Drilling will be done using dual wall, percussion hammer, reverse air rotary techniques (AP-1000), or Approved Equivalent. The anticipated depth for this well is 190 feet. The well to be used for extraction will be completed as a 6-inch inside diameter well with low carbon steel casing and stainless steel well screen. Screens will be continuous slot and screen size will be selected based on sieve analysis results from the test boring (Task 2). The anticipated screen length is up to 30 feet. Stainless-steel centralizers will be used on a 2.5-foot blank section (sump) just below the screened interval, 10 feet above the screened interval, and at 50-foot intervals above the screened interval, as appropriate. The boring at this location will be initially drilled as an exploratory boring. Depending on the hole condition, this boring may be re-entered for completion of the extraction well.

While the casing is under tension, filter material (the size of which will be selected based on sieve analysis of the materials within the saturated zone) will be placed to approximately five (5) feet above the well screen. Filter material will be emplaced as a "sand slurry" by using a tremie pipe and water. The depth of the filter material will be checked by sounding using a weighted measuring tape. A one-foot layer of fine sand (200 mesh) will be placed on top of the coarse filter pack and approximately five feet of bentonite chips (hydrated) will be placed on top of the fine sand. A cement/bentonite slurry (95/5 by weight) will be placed by tremie pipe above the fine sand to within 5 feet of the ground surface.

The upper five feet of the annulus will be filled with concrete. An approximately 6-foot long 8-inch i.d. (nominal inner diameter) steel protective casing (minimum 3/16-inch thick) will be embedded in the concrete to at least three feet below grade and fitted with a locking cap. The steel casing will extend approximately 2.5 to 3 feet above the surrounding ground surface. A concrete pad, six (6) inches thick and approximately 4.5 feet square will be constructed around the protective casing. A minimum of three protective bollards will be emplaced around the well head. The bollards will consist of 4-inch i.d. steel pipe extending at least three (3) feet above and below the ground surface and will be filled with concrete or cement.

Well development will not proceed until at least 24 hours following well completion. The well will be developed by surging and pumping until the produced water is relatively free of sand and silt.

3.4 Task 4 - Pump Installation in Well 402 and Pumping Test

The new well 402 (and second well, if necessary) will be equipped with a temporary submersible pump. The pump will likely consist of a 7.5 hp submersible pump with an operating range of 45 to 95 gpm at a total dynamic head of 190 to 340 feet. The piping system will include a temporary flow meter and a discharge pipe from the wellhead to the pipeline that currently collects water from well 343, such that the water produced during pumping of well 402 is directed to the Don Plant cooling system.

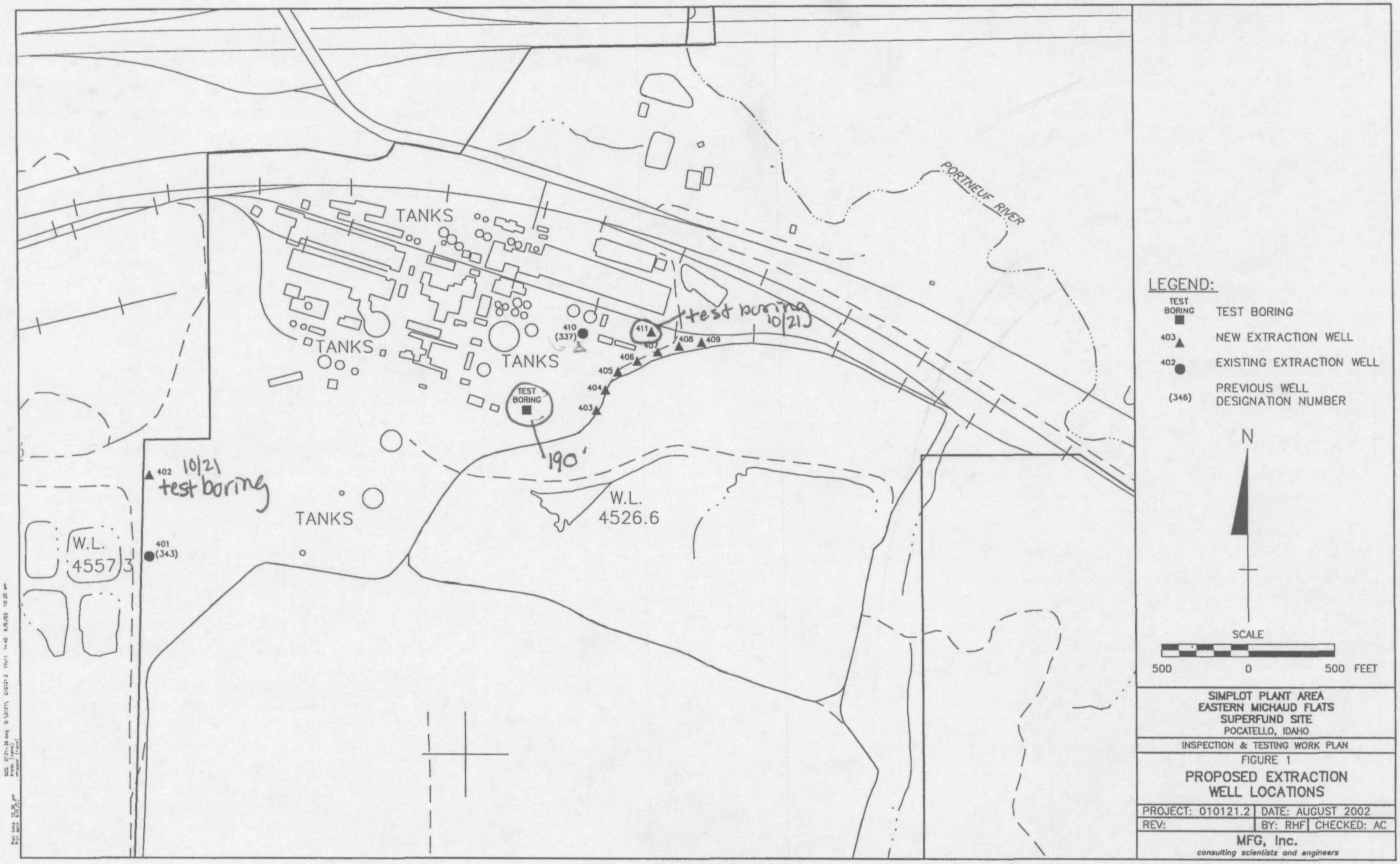
An intial step-drawdown test will be conducted to select an appropriate rate for a longer-term test. The longer-term test will consist of a minimum 24 hours pumping followed by water level measurements until recovery to 90% of static water levels. Water levels will be monitored using pressure transducers in the pumping well, monitoring wells 307 and 308, and observation well 336.

4.0 REFERENCES

MFG, Inc., 1997. Comparative Analysis Report, FS Sections 7 and 8, Simplot Subarea, Eastern Michaud Flats Superfund Site.

MFG, Inc., 2002. Draft Remedial Design Report, Groundwater Extraction System, Simplot Plant Area, Eastern Michaud Flats Superfund Site. August 5.

FIGURES


PORTNEUF RIVER
TANKS
TANKS
TANKS
TANKS
410
(337)
411
407
408
409
406
405
404
403
TEST BORING
test boring
10/21
190'
402
10/21
test boring
401
(343)
W.L.
4526.6
W.L.
4557.3
LEGEND:
TEST BORING
TEST BORING
403
NEW EXTRACTION WELL
402
EXISTING EXTRACTION WELL
(346)
PREVIOUS WELL DESIGNATION NUMBER
N
SCALE
500
0
500 FEET
SIMPLOT PLANT AREA
EASTERN MICHAUD FLATS
SUPERFUND SITE
POCATELLO, IDAHO
INSPECTION & TESTING WORK PLAN
FIGURE 1
PROPOSED EXTRACTION WELL LOCATIONS
PROJECT: 010121.2
DATE: AUGUST 2002
REV:
BY: RHF
CHECKED: AC
MFG, Inc.
consulting scientists and engineers

APPENDIX A

MFG, Inc.

STANDARD OPERATING PROCEDURE No. 1

FIELD DOCUMENTATION

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the protocol for documenting field activities. MFG field personnel shall document field activities on formatted field records and other appropriate data sheets. These formatted record and data sheets will be part of the MFG project file; all forms must be filled out carefully and completely by one of the personnel actually performing the field activities.

2.0 PROCEDURES

2.1 Daily Field Record

The MFG field representative will prepare a Daily Field Record form (Figure SOP-1-1) for each day of field work. Documentation on the multiple-page form will include:

A. Project identification;

B. Date;

C. Time on job (beginning and ending time);

D. Weather conditions;

E. Activity description;

F. List of personnel and visitors on site;

G. Safety equipment used and monitoring performed;

H. Waste storage inventory (if any);

I. Chronological record of activities and events;

J. Comments and variances from project work plan;

K. Content of telephone conversations; and

L. Signature of the MFG field representative.

The MFG field representative will document all details that would be necessary to recreate the day's activities and events at a later time, using as many additional sheets as necessary. The Daily Field Record also will be used to document field activities that may not be specified on other field record forms. Other activity-specific documentation requirements to be recorded on the Daily Field Record are discussed in the MFG Standard Operating Procedure for each activity.

3.0 DOCUMENTATION

3.1 Field Record Forms

In addition to the Daily Field Record, MFG field personnel will complete specific MFG field record forms applicable to the field activities being conducted. The procedures for completion of activity-specific field record forms are presented in the applicable MFG Standard Operating Procedures. MFG field record forms include:

- Daily Field Record (SOP No. 1);
- Chain-of-Custody Record and Request for Analysis (SOP No. 2);
- Field Log of Borehole by Cuttings (SOP No. 4);
- Field Log of Borehole by Coring (SOP No. 4);
- UST Closure Field Record (SOP No. 3);
- Well Construction Summary (SOP No. 6);
- Well Development Record (SOP No. 7);

- Geophysical Log (SOP No. 5);
- Water Level Monitoring Record (SOP No. 11);
- Pumping Test Record (SOP No. 14);
- Eh Data Sheet (SOP No. 13);
- Groundwater Sampling Record (SOP No. 12); and
- Surface Water Sampling Record (SOP No. 12).

Additional field record forms and applicable procedures may be created for project-specific activities, as necessary.

3.2 Records Management

All original field forms will be filed with the appropriate project's records.

4.0 QUALITY ASSURANCE

4.1 Form Review and Filing

All completed field forms will be reviewed by the Project Manager or project designated QA/QC reviewer. Any necessary corrections will be made in pen with a single-line strike out that is initialed and dated.

DAILY FIELD RECORD

DATE:

PAGE 1 of ________

Project No.: ______________________ Project Name: ______________________

Location: ______________________ Time on Job: __________ AM PM to: __________ AM PM

Weather Conditions: ______________________

Activity: ______________________

PERSONNEL ON SITE

Name	Company	Time In	Time Out

VISITORS ON SITE

Name	Company/Agency	Time In	Time Out

PERSONAL SAFETY

	Protective Gloves		Hard Hat		Tyvek Coveralls (W/Y)
	Protective Boots		Safety Goggles/Glasses		Air Purifying Respirator

Other Safety Equipment (describe):

Monitoring Equipment:

Field Calibration:

WASTE STORAGE INVENTORY

Container Type	Container ID	Description of Contents and Quantity	Location

Number of empty drums on Site: Location of drums stored on Site:

Signature of Field Representative: ______________________ Date: __________

Notes: _

Revision 5/25/00

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FIGURE SOP-1-1. DAILY FIELD RECORD

DAILY FIELD RECORD (continued)	DATE:	PAGE _____ of _____

TIME	DESCRIPTION OF DAILY ACTIVITIES & EVENTS

COMMENTS & CHANGES FROM WORK PLAN

TIME	TELEPHONE CONVERSATION RECORD

Signature of Field Representative:

____

Revision 5/25/00

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FIGURE SOP-1-1. DAILY FIELD RECORD

MFG, Inc.

STANDARD OPERATING PROCEDURE No. 2

SAMPLE CUSTODY, PACKAGING AND SHIPMENT

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the protocol to be followed for sample custody, packaging and shipment. The procedures presented herein are intended to be general in nature. If warranted, appropriate revisions may be made when approved in writing by the MFG Project Manager.

This SOP applies to any liquid or solid sample that is being transported by the sampler, a courier or an overnight delivery service.

2.0 PROCEDURES

The objectives of this packaging and shipping SOP are: to minimize the potential for sample breakage, leakage or cross contamination; to provide for preservation at the proper temperature; and to provide a clear record of sample custody from collection to analysis.

2.1 Packaging Materials

The following is a list of materials that will be needed to facilitate proper sample packaging:

X Chain-of-Custody Record forms (see Figure SOP-2-1);

X Coolers (insulated ice chests) or other shipping containers as appropriate to sample type;

X Transparent packaging tape;

X Zip-lock type bags (note: this is used as a generic bag type, not a specific brand name);

X Protective wrapping and packaging material;

X Contained ice (packaged and sealed to prevent leakage when melted) or "Blue Ice"; and

X Chain-of-Custody seals.

2.2 Sample Custody from Field Collection to Laboratory

After samples have been collected, they will be maintained under chain-of-custody procedures. These procedures are used to document the transfer of custody of the samples from the field to the designated analytical laboratory. The same chain-of-custody procedures will be used for the transfer of samples from one laboratory to another, if required.

The field sampling personnel will complete a Chain-of-Custody Record and Request for Analysis form (CC/RA form, Figure SOP-2-1) for each separate container of samples to be shipped or delivered to the laboratory for chemical or physical (geotechnical) analysis. Information contained on the triplicate, carbonless form will include:

1. Project identification;
2. Date and time of sampling;
3. Sample identification;
4. Sample matrix type;
5. Sample preservation method(s);
6. Number and types of sample containers;
7. Sample hazards (if any);
8. Requested analysis(es);
9. Requested sample turnaround time;
10. Method of shipment;
11. Carrier/waybill number (if any);

12. Signature of sampling personnel;

13. Name of MFG Project Manager;

14. Signature, name and company of the person relinquishing and the person receiving the samples when custody is being transferred;

15. Date and time of sample custody transfer; and

16. Condition of samples upon receipt by laboratory.

The sample collector will cross out any blank space on the CC/RA form below the last sample number listed on the part of the form where samples are listed. The samples will be carefully packaged into shipping containers/ice chests.

The sampling personnel whose signature appears on the CC/RA form is responsible for the custody of a sample from time of sample collection until the custody of the sample is transferred to a designated laboratory, a courier, or to another MFG employee for the purpose of transporting a sample to the designated laboratory. A sample is considered to be in their custody when the custodian: (1) has direct possession of it; (2) has plain view of it; or (3) has securely locked it in a restricted access area.

Custody is transferred when both parties to the transfer complete the portion of the CC/RA form under "Relinquished by" and "Received by." Signatures, printed names, company names, and date and time of custody transfer are required. Upon transfer of custody, the MFG sampling personnel who relinquished the samples will retain the third sheet (pink copy) of the CC/RA form. When the samples are shipped by a common carrier, a Bill of Lading supplied by the carrier will be used to document the sample custody, and its identification number will be entered on the CC/RA form. Receipts of Bills of Lading will be retained as part of the permanent documentation in the MFG project file.

2.3 Sample Custody Within Laboratory

The designated laboratory will assume sample custody upon receipt of the samples and CC/RA form. Sample custody within the analytical laboratory will be the responsibility of designated laboratory personnel. The laboratory will document the transfer of sample custody and receipt by the laboratory by signing the correct portion of the CC/RA form. Upon receipt, the laboratory sample custodian will note the condition of the samples, by checking the following items:

1. Agreement of the number, identification and description of samples received by comparison with the information on the CC/RA form; and
2. Condition of samples (no air bubbles in VOA containers; any bottle breakage; leakage, cooler temperature, etc.).

If any problems are discovered, the laboratory sample custodian will note this information on the "Laboratory Comments/Condition of Samples" section of the CC/RA form, and will notify the MFG sampling personnel or Project Manager immediately. The MFG Project Manager will decide on the final disposition of the problem samples.

The laboratory will retain the second sheet (yellow copy) of the CC/RA form and return the first sheet (white original) to MFG with the final laboratory report of analytical results. The original of the CC/RA form will be retained as part of the permanent documentation in the MFG project file.

A record of the history of the sample within the laboratory containing sample status and storage location information will be maintained in a logbook, or a computer sample tracking system, at the laboratory. The following information will be recorded for every sample access event:

1. Sample identification;
2. Place of storage;
3. Date(s) and time(s) of sample removal and return to storage;
4. Accessor's name and title;
5. Reason for access; and

6. Comments/observations (if any).

The laboratory will provide MFG with a copy of the logbook or computer file information pertaining to a sample upon request.

2.4 Sample Custody During Inter-Laboratory Transfer

If samples must be transferred from one laboratory to another, the same sample custody procedures discussed above will be followed. The designated laboratory person (sample custodian) will complete a CC/RA Record (MFG form or similar) and sign as the originator. The laboratory relinquishing the sample custody will retain a copy of the completed form. The laboratory receiving sample custody will sign the form, indicating transfer of custody, retain a copy, and return the original record to MFG with the final laboratory report of analytical results. The CC/RA Record will be retained as part of the permanent documentation in the MFG project file.

2.5 Packaging and Shipping Procedure

Be sure that all sample containers are properly labeled and all samples have been logged on the Chain-of-Custody Request for Analysis form (CC/RA, SOP-2-1) in accordance with the procedures explained above and in the MFG SOPs entitled WATER QUALITY SAMPLING and SOIL/SEDIMENT SAMPLING FOR CHEMICAL ANALYSIS.

All samples should be packed in the cooler so as to minimize the possibility of breakage, cross-contamination and leakage. Before placing the sample containers into the cooler, be sure to check all sample bottle caps and tighten if necessary. Bottles made of breakable material (e.g., glass) should also be wrapped in protective material (e.g., bubble wrap, plastic gridding, or foam) prior to placement in the cooler. Place each bottle or soil liner into two zip-lock bags to protect from cross-contamination and to keep the sample labels dry. Place the sample containers upright in the cooler. Avoid stacking glass sample bottles directly on top of each other.

If required by the method, samples should be preserved to 4°C prior to the analysis. Water ice or "blue ice" will be used to keep the sample temperatures at 4°C. The ice will be placed in two zip-lock bags if the samples are to be transported by someone other than the MFG sampler (e.g., a courier or overnight delivery service). Place the zip-lock bags of ice in between and on top of the sample containers so as to maximize the contact between the containers and the bagged ice. If the MFG sampler is transporting the samples to the laboratory shortly after sample collection, the water ice may be poured over and between the sample bottles in the cooler.

If there is any remaining space at the top of the cooler, packing material (e.g., styrofoam pellets or bubble wrap) should be placed to fill the balance of the cooler. After filling the cooler, close the top and shake the cooler to verify that the contents are secure. Add additional packaging material if necessary.

When transport to the laboratory by the MFG sampler is not feasible, sample shipment should occur via courier or overnight express shipping service that guarantees shipment tracking and next morning delivery (e.g., Federal Express Priority Overnight). In this case, place the chain-of-custody records in a zip-lock bag and place the bag on top of the contents within the cooler. Tape the cooler shut with packaging tape. Packaging tape should completely encircle the cooler, and a chain-of-custody seal should be signed and placed across the packaging tape, and across at least one of the opening points of the container.

Retain copies of all shipment records provided by the courier or overnight delivery service and maintain in the project's file.

2.6 Documentation and Records Management

Daily Field Records or a field notebook with field notes will be kept describing the packaging procedures and the method of shipments. Copies of all shipping records and chain-of-custody records will be retained in the project files.

3.0 QUALITY ASSURANCE

The Project Manager or designated QA reviewer will check and verify that documentation has been completed and filed per this procedure.

SOP-2-1

CHAIN-OF-CUSTODY RECORD AND REQUEST FOR ANALYSIS

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Tel: (415) 495-7110
Fax: (415) 495-7107

☐ Santa Ana Office
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Santa Ana, CA 92705-3731
Tel: (714) 973-3090
Fax: (714) 973-3097

☐ Seattle Office
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Suite 101
Lynnwood, WA 98036-5707
Tel: (425) 921-4000
Fax: (425) 921-4040

☐ ______________

PROJECT NO: ______________ PROJECT NAME: ______________ PAGE: ______ OF: ______

SAMPLER (Signature): ______________ PROJECT MANAGER: ______________ DATE: ______________

METHOD OF SHIPMENT: ______________ CARRIER/WAYBILL NO: ______________ DESTINATION: ______________

SAMPLES													ANALYSIS REQUEST								
	Sample			Preservation						Containers			Constituents/Method					Handling			Remarks
Field Sample Identification	DATE	TIME	Matrix*	HCl	HNO_3	H_2SO_4	COLD		FILTRATION*	VOLUME (ml/oz)	TYPE*	NO.						HOLD	RUSH	STANDARD	

TOTAL NUMBER OF CONTAINERS

LABORATORY COMMENTS/CONDITION OF SAMPLES Cooler Temp:

RELINQUISHED BY:					RECIEVED BY:		
SIGNATURE	PRINTED NAME	COMPANY	DATE	TIME	SIGNATURE	PRINTED NAME	COMPANY
							LABORATORY

*KEY Matrix: AQ - aqueous NA - nonaqueous SO - soil SL - sludge P - petroleum A - air OT - other Containers: P - plastic G - glass T - teflon B - brass OT - other Filtration: F - filtered U - unfiltered

DISTRIBUTION: PINK: Field Copy YELLOW: Laboratory Copy WHITE: Return to Originator

MFG, Inc.

STANDARD OPERATING PROCEDURE No. 4

SUPERVISION OF EXPLORATORY BORINGS

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the protocol to be followed during the drilling and logging of exploratory borings by MFG. Exploratory borings (pilot holes) may be drilled to obtain samples of the subsurface strata or to run borehole geophysical logs. Borings will be either backfilled with grout or completed as monitoring wells or piezometers.

The procedures presented herein are intended to be general in nature. As site-specific conditions become known, appropriate modifications to the procedures may be made when approved in writing by the MFG Project Manager.

2.0 PROCEDURES

2.1 Drilling

For any site or drilling location, the selection of drilling methods will be based on: (1) availability and cost of the method; (2) suitability for the type of geologic materials at the site (e.g., consolidated, unconsolidated); and (3) potential effects on sample integrity (influence by drilling fluids and potential for cross contamination between aquifers). Some commonly used drilling methods include hollow-stem auger method, cone penetrometer testing (CPT) method, direct-push geoprobe method, hydraulic rotary method, cable tool method, or casing-hammer air rotary method. Synthetic polymer drilling fluid additive should be used only if a boring: (1) will not be sampled for chemical analysis; (2) will not be completed as a monitoring well; or (3) if cuttings return and/or borehole integrity cannot be achieved by any other method.

Exploratory borings for monitoring wells and piezometers will be drilled in a manner that will minimize the potential for cross contamination between aquifers. The actual depth of each exploratory boring will be specified by the MFG field geologist assigned to the drill rig and will be based on the intended use of the boring. No solvents or petroleum-based products will be used for lubricating any drilling equipment (rods, bit, augers, mud pit, etc.) which will contact the borehole or the drilling fluid. For air rotary drilling, an air filter will be installed between the air compressor and the drill pipe to intercept oil droplets.

The drilling equipment in which fluid (including air) circulates, including drive samplers and bits, will be thoroughly steam cleaned before and after drilling of each exploratory boring. Only clean, potable water from a municipal supply will be used as makeup water for drilling fluid and for decontamination of drilling equipment. An acid rinse (e.g., 0.1 N HCl) or solvent rinse (e.g., methanol or hexane) may be used to supplement these procedures if tarry or oily deposits are encountered during drilling. Drilling equipment cleaned in this manner will be thoroughly steam cleaned prior to reuse or leaving the site.

To ensure that the specified equipment has been provided by the drilling contractor, prior to drilling the MFG field geologist will measure and record the outside diameter of the drill bit or augers and, when using the hollow stem auger method, the inside diameter of the augers.

During drilling, the MFG field geologist may choose to periodically measure and record the depth to water within the drill casing. The position of the lead drill casing will be recorded each time a water level measurement is taken. When the total depth of a boring is reached, the water level within the drill casing will be measured.

If the boring is to be completed as a monitoring well or a piezometer, the final borehole diameter will be sufficiently large to allow placement of a specified type and size of well casing, screen and filter pack. The MFG field geologist will measure and record the total depth of the final borehole at the completion of drilling.

The MFG field geologist shall specify to the driller the penetration rate, depth of soil sample collection, method of sample retrieval, and any other matters which pertain to the satisfactory completion of the exploratory borings.

Soil cuttings and drilling fluid generated during drilling should be temporarily stored in steel drums or other approved containers. Final disposal of the soil cuttings and drilling fluid will be conducted in accordance with all legal requirements and with procedures discussed in the MFG SOP entitled STORAGE AND DISPOSAL OF SOIL, DRILLING FLUIDS, AND WATER GENERATED DURING FIELD WORK.

2.2 Sampling and Logging

Representative samples of cores and/or drill cuttings may be obtained and evaluated. A detailed lithologic log of these samples should be made.

Selected samples may be retained for further physical analysis. Soil samples may also be obtained for chemical analysis. Sample collection and preservation for chemical analysis will be in accordance with the MFG SOP entitled SOIL/SEDIMENT SAMPLING FOR CHEMICAL ANALYSIS. Selected samples that illustrate specific geologic features may be retained and shall be labeled with boring number and appropriate sample interval.

2.2.1 Obtaining Samples

When samples are collected, they should be obtained by one or both of the following methods described below.

A. Coring -- Cores will be collected from selected intervals of the exploratory borings. Core barrels, Pitcher tubes, modified California drive samplers or other split-spoon drive samplers will be used to obtain the soil cores. The MFG field geologist will carefully record on a boring log information which applies to the coring, such as rate of penetration, coring smoothness, core recovery, intervals of core loss, zones of lost circulation of drilling fluid, hammer weight, drop length and blow counts, as appropriate to the drilling method.

Cores may be retained for future examination and/or preserved for chemical or geotechnical analysis. If they are retained, the cores will be stored and labeled to show project, boring number, date, and cored interval.

B. Collecting Cuttings -- The MFG field geologist may collect cuttings from the drilling return fluid, air return from a cyclone separator, or the auger blade for every five-foot (or more frequent) increment of the exploratory boreholes. Sampling and logging should be performed in accordance with the following procedures (Note: Items 2 through 6 do not apply to drilling methods that do not use a drilling fluid, e.g., hollow stem auger, push point sampler, etc.):

1. The height of the drilling table above ground surface, lengths of the drill bit, sub and drill collars, and length of drill rods or augers should be taken into account in calculating the depth of penetration.

2. A small-diameter, fine-mesh hand screen or a shovel may be used to obtain a sample of the cuttings from the boring by holding the sampling device directly in the flow of the drilling return fluid or cyclone separator.

3. A sample will be obtained from the drilling return fluid or cyclone separator by leaving the sampling device in place only for the brief period required to collect an adequate sampling volume.

4. The most representative cuttings samples are usually obtained whenever the driller stops advancing the hole and circulates drilling fluid or air prior to adding another joint of drill rod.

5. Keep in mind that the deeper the hole, the longer cuttings at the drill bit take to reach the surface. The travel time for cuttings to reach the surface may be estimated each time the driller adds a new length of drill rod by timing the first arrival of cuttings after fluid or air circulation is resumed. This travel time should be used along with the depth of penetration to estimate the start and finish of each sampling interval.

6. In hydraulic rotary drilling, carefully wash the cutting sample in a bucket of fresh water by slowly shaking the screen while the sample is submerged, to wash away the drilling fluid.

7. For all drilling methods, place the cutting samples on a sampling table, labeled in consecutive order. If the sample is to be retained, place the sample in a plastic or cloth sample bag labeled with the boring number and sample interval. The retained samples will later be used during preparation of a detailed lithologic log.

2.3 Logging of Boreholes

The drill-rig operator and the MFG field geologist should discuss significant changes in material penetrated by the drill bit, changes in drilling conditions, hydraulic pressure, drilling action, and drilling fluid circulation rate. The MFG field geologist will be present during drilling of exploratory borings and will observe and record such changes by time and depth. When using a drilling method that does not involve the use of a wet drilling fluid, the MFG field geologist will evaluate the relative moisture content of the samples and note zones that produce water. The MFG field geologist will record such field notes to use later in preparing a detailed lithologic log.

Core samples and selected cuttings that are collected and retained during the drilling of the exploratory borings shall be examined to evaluate the lithologic properties. A detailed lithologic log for the exploratory borings shall be completed using MFG's Log of Boring by Cuttings (Figure SOP-4-1) or Field Log of Borehole by Coring (Figure SOP-4-2). The lithologic description of the log should include soil or rock type, color, grain size, texture, hardness, degree of induration, calcareous content, indications of contamination, and other pertinent information. Color should be described using the Munsell Color Chart. Soil type should be described using the Unified Soil Classification System. When the Field Log of Borehole by Coring form is used, it shall include the method of sample collection (coring, cuttings) and the sample collection interval (Figure SOP-4-2), if any samples are collected.

2.4 Geophysical Logs

The MFG SOP entitled GEOPHYSICAL LOGGING discusses in detail the steps to be followed when performing geophysical logs of exploratory borings. Geophysical logging will be performed generally in uncased, fluid-filled boreholes. Following completion of the drilling, spontaneous potential, single-point resistance, lateral resistivity, natural gamma or other logs may be made for each exploratory boring immediately after the drilling fluid has been circulated to remove all of the cuttings. When performed, geophysical logging shall be done as quickly and efficiently as possible, while the wall of the borehole is in good condition, to minimize the possibility of trapping or entangling the downhole probes. Instruments on the logging unit should be adjusted to give the maximum definition of strata boundaries.

2.5 Sealing and Abandonment

For borings (pilot holes) not used to install a monitoring well and/or piezometer, the exploratory borings will be abandoned by sealing the hole with cement grout or other approved sealing agents. The MFG field geologist shall inspect the grout for adequate mixing prior to placement in the borehole.

If the borehole is dry and is less than 10-feet deep, the grout or other approved sealant may be poured slowly from the ground surface into the borehole. The grout should be added in one continuous pour before its initial set. If the borehole is greater than 10-feet deep, or if more than 2-feet of water is present in the borehole, the grout should be placed in one continuous pour by pumping through a tremie hose or pipe. The tremie hose or pipe initially shall be placed near the bottom of the bore hole and shall remain submerged in the grout during the entire grouting operation. Grout will continue to be pumped until return of fresh grout (uncontaminated by drilling fluid) is witnessed at the ground surface.

The preferred grout mix is one (1) sack of Type I-II Portland cement, five (5) percent by weight of powdered bentonite, per 8.5 gallons of water. If a high-yield bentonite grout (trade names Quik-Gel, Super Gel X, etc.) is used, the powdered bentonite percentage should be reduced to two (2) percent. The grout mixture may be modified to meet local regulations or site-specific conditions or specifications.

2.6 Documentation and Records Management

Field notes recorded by the MFG field geologist during the drilling of each exploratory boring shall be transferred to the log forms (Figures SOP-4-1 and SOP-4-2). The original logs shall be sent to the MFG office and placed in the MFG project file. A copy of the logs will be retained in the field file for the project. For preparation of the report, data from the field boring logs may also be transferred to another format.

3.0 QUALITY ASSURANCE

Field notes and field forms completed by the field geologist shall be reviewed by the field supervisor and the MFG Project Manager or other designated QA officer before they are placed into project files. Deviation from this SOP or a project-specific work plan shall be identified and described in field notes. The QA review will be recorded on the reviewed originals by initials of reviewer and date.

LOG OF BORING BY CUTTINGS

BORING NO.: ___ **PAGE** ___ **OF** ___

SITE NAME:	**PROJECT NO.:**	**BORING LOCATION:**
DRILLING COMPANY:	**DRILLER:**	**ELEVATION AND DATUM:**

DRILLING METHOD:	**DATE STARTED:**	**DATE FINISHED:**
SITE & TYPE OF CASING:	**DRILL BIT:**	**COMPLETION DEPTH:**
SAMPLER METHOD:	**LOGGED BY:**	**CHECKED BY:**

SAMPLER TYPE:	**LENGTH:**	**DROP:**

DRILLING TIME RECORD					DEPTH		HYDRAULIC PRESSURE	DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME								
FROM	TO	FROM	TO	MIN.	FROM	TO				

ABBREVIATIONS:

DRILLING ACTION		CALC. CONTENT	HYD. PRESS.
E: even, smooth	r: Slightly rough	N: Non-calc.	N: None
C: Crunchy	R: Moderately rough	S: Slightly	L: Low
I: Intermittently rough	R̲: Very rough	M: Moderately	M: Medium
		V: Very	F: Full

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FIGURE SOP-4-1. FIELD LOG OF BOREHOLE BY CUTTINGS (Page 1 of 2)

LOG OF BORING BY CUTTINGS

BORING NO.: ___	PAGE ___ OF ___

SITE NAME:	PROJECT NO.:	BORING LOCATION:	
DRILLING COMPANY:	DRILLER:	ELEVATION AND DATUM:	
DRILLING METHOD:		DATE STARTED:	DATE FINISHED:
SITE & TYPE OF CASING:		DRILL BIT:	COMPLETION DEPTH:
SAMPLER METHOD:		LOGGED BY:	CHECKED BY:
SAMPLERTYPE:	LENGTH: / DROP:		

DRILLING TIME RECORD					DEPTH		HYDRAULIC PRESSURE	DRILLING ACTION	CALC. CONTENT	DESCRIPTION AND DRILLERS NOTES: (material, color, texture, hardness and other notes)
DEPTH		TIME								
FROM	TO	FROM	TO	MIN.	FROM	TO				

ABBREVIATIONS:

DRILLING ACTION

- E: even, smooth
- C: Crunchy
- I: Intermittently rough
- r: Slightly rough
- R: Moderately rough
- R: Very rough

CALC. CONTENT

- N: Non-calc.
- S: Slightly
- M: Moderately
- V: Very

HYD. PRESS.

- N: None
- L: Low
- M: Medium
- F: Full

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FIGURE SOP-4-1. FIELD LOG OF BOREHOLE BY CUTTINGS (Page 2 of 2)

MFG, INC. 4900 Pearl East Circle, Suite 300W Boulder, Colorado 80301-6118 (303) 447-1823 FAX: (303) 447-1836	LOG OF BORING (Page 1 of ___)	
	Location:	Ground Elevation:
	Drilling Agency:	Date Finished:
	Drilling Method:	Drill Bit:
	Sampler Type:	Logged By:
Project No.		

Depth in Feet	DESCRIPTION	USCS Class	Sampling	Blows/Ft.	Drive Recovery	PID (ppm-v)	REMARKS
0							
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							

FIGURE SOP-4-2. FIELD LOG OF BOREHOLE BY CORING (Page 1 of 3)

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Project No.

LOG OF BORING

(Page 2 of ___)

Location:
Drilling Agency:
Drilling Method:
Sampler Type:

Ground Elevation:
Date Finished:
Drill Bit:
Logged By:

Depth in Feet	DESCRIPTION	USCS Class	Sampling	Blows/Ft.	Drive Recovery	PID (ppm-v)	REMARKS
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							

FIGURE SOP-4-2. FIELD LOG OF BOREHOLE BY CORING (Page 2 of 3)

MFG, INC. 4900 Pearl East Circle, Suite 300W Boulder, Colorado 80301-6118 (303) 447-1823 FAX: (303) 447-1836	LOG OF BORING (Page 3 of ___)
Project No.	Location: / Ground Elevation: Drilling Agency: / Date Finished: Drilling Method: / Drill Bit: Sampler Type: / Logged By:

Depth in Feet	DESCRIPTION	USCS Class	Sampling	Blows/Ft.	Drive Recovery	PID (ppm-v)	REMARKS
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							
41							
42							
43							
44							

FIGURE SOP-4-2. FIELD LOG OF BOREHOLE BY CORING (Page 3 of 3)

MFG, Inc.

STANDARD OPERATING PROCEDURE No. 6

INSTALLATION OF MONITORING WELLS AND PIEZOMETERS

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the protocol to be followed during installation of monitoring wells and piezometers by MFG, Inc. The procedures presented herein are intended to be general in nature. As site-specific conditions become known, appropriate modifications of the procedures may be made when approved in writing by the MFG Project Manager.

2.0 PROCEDURES

2.1 Monitoring Well Installation

Each monitoring well will be designed to register the potentiometric surface and to permit water sampling of a specific depth zone encountered beneath the drill site. Separate monitoring wells may be completed, as necessary, in the different water-yielding zones underlying the site. The MFG field geologist, in consultation with the MFG Project Manager, will specify the exact depths of screened intervals using the lithologic log and geophysical log (if performed) for control. Drilling and logging of the exploratory borings for the monitoring wells will be conducted in accordance with the MFG SOP entitled SUPERVISION OF EXPLORATORY BORINGS. Construction and completion of all monitoring wells will be in general conformance with the following procedures. Specific monitoring well completion requirements may vary in accordance with project-specific work plans and/or local regulatory agency guidance.

2.1.1 Screens and Riser Casing

The monitoring well assembly shall consist of flush joint, threaded casing composed of mild steel, stainless steel or polyvinyl chloride (PVC) Schedule 40 (minimum). The threaded joints will have O-ring seals. Steel casing joints may be welded rather than threaded. The inside diameter of both the perforated and unperforated casing will be sufficiently large to permit easy passage of an appropriate water-level probe, equipment for development and purging of wells, and for collection of groundwater samples.

The perforated casing (well screen) will be factory slotted. The perforations will be compatible in size with the selected filter material. These perforated casing sections are generally not intended to provide optimum flow but only to provide hydraulic connection between the pervious material in the water-yielding zone and the monitoring well.

Prior to well construction, the MFG field geologist will inspect the blank and perforated casing delivered to the job site to verify that it meets the project specifications.

When the total depth of a boring has been reached, and prior to installation of the well casing, the MFG field geologist will measure and record the depth to water in the borehole.

Upon completion of drilling and/or geophysical logging, the monitoring well casing and screen will be assembled and lowered to the bottom of the boring. The monitoring well assembly will be designed so that the well screen is approximately adjacent to the water-yielding zone that is to be monitored. The bottom of the screen will be approximately flush with the bottom of the well and will be closed with a threaded PVC cap or plug, or a slip cap secured with stainless steel screws. No PVC cement or other solvents are permitted to be used to fasten the joints of the casing or screen. Centralizers spaced at the top and bottom of the screened interval and not more than 40 feet apart along the casing may be used to center the well assembly in the borehole, unless the boring is drilled by a low annular space method and the well is installed with the drill casing in place. Wells installed prior to pulling low annular space drill casing will be centered by the inside walls of the drill casing.

If well casing assembly is being performed by a drilling subcontractor, the MFG field geologist will observe and inspect the assembly, insuring that the bottom cap is threaded or secured with stainless steel screws, O-rings are properly placed in the joints, the joints are completely tightened, and the blank and perforated intervals are constructed as specified. The MFG field geologist will measure the location of the top and bottom of the perforated interval by measuring the distances from the joint above the perforated interval to the top slot and from the base of the bottom cap to the bottom slot.

When using the mud rotary drilling technique, after the monitoring well assembly has been lowered to the specified depth, clean water may be circulated downward through the well casing and upward through the annular space between the borehole wall and the monitoring well casing. Circulation will continue until the suspended sediment in the return fluid has been thinned.

If the well is greater than 50 feet deep, the casing assembly will be held under tension prior to and during emplacement of the filter pack and seal.

2.1.2 Filter Material

Filter material will be a well-graded, clean sand with less than 2 percent by weight passing a No. 200 sieve and less than 5 percent by weight of calcareous material.

Filter sand will be tremied into the annular space using a one-inch diameter (or larger) pipe, in a calculated quantity sufficient to fill the annular space to a level of about two feet above the top of the perforated casing. The required height of the filter pack above the top of the perforated casing may vary by jurisdiction. The depth to the top of the filter pack must be verified by measuring, using the tremie pipe or a weighted steel tape. When use of a tremie pipe is not feasible, the filter sand may be poured slowly between the well casing and the inside walls of the auger, and the drill casing may be removed in stages.

2.1.3 Seal

Once the depth to the top of the filter pack has been verified, a layer of bentonite pellets will be emplaced by pouring the pellets into the annular space in a calculated quantity sufficient to fill the annular space to a level at least one foot above the top of the filter pack. The depth to the top of the bentonite pellets layer must be verified by measuring, using the tremie pipe or a weighted steel tape. When the bentonite pellets are placed above the zone of saturation, they will be hydrated, after they have been emplaced, by adding clean, potable municipal water. Approximately 3 gallons of water should be added for every foot of bentonite pellets. More water may be required when completing a well in relatively permeable material. The bentonite pellets will be hydrated in lifts no greater than 3 feet.

A bentonite/cement grout seal or other approved sealant will be emplaced above the bentonite pellet layer after it has been allowed to hydrate for a minimum of ½ hour. If the depth to the top of the bentonite pellet layer is dry and is less than 10 feet deep, the grout may be poured slowly from the ground surface into the annular space. The grout should be added in one continuous pour before its initial set. If the depth is greater than 10 feet deep, or if more than two feet of water is present in the annular space, the grout should be placed in one continuous pour by pumping through a tremie hose or pipe. The tremie hose or pipe initially shall be placed near the top of the bentonite seal and shall remain submerged in the grout during the entire grouting operation. When constructing a well or piezometer inside a low annular space drill casing, the drill casing may be used as a tremie pipe by pouring the grout down the annular space between the well casing and the inner wall of the drill casing. Grout will continue to be pumped until return of fresh grout is witnessed at the ground surface.

The bentonite/cement grout mix should be one (1) sack of Type I-II Portland cement, five (5) percent by weight (of cement) of powdered bentonite, per 8.5 gallons of water. If a high-yield bentonite (trade names Quik-Gel, Super Gel X, etc.) is used, the powdered bentonite percentage should be reduced to two (2) percent. An alternative grout mixture may be used if approved by the applicable regulatory agency and the MFG Project Manager. Only clean water from a municipal supply will be used to prepare the grout. The grout seal will extend from the top of the bentonite pellet layer to near the ground surface. After grouting, no work will be done on the monitoring well until the grout has set for a minimum of 24 hours.

When the casing hammer air rotary or similar method is used to complete the borehole for a monitoring well, the protective casing will be jacked out of the borehole gradually as the filter pack, bentonite pellets, and cementing operations are in progress.

2.1.4 Capping Monitoring Well

Upon completion of the work, a suitable watertight, cap or plug will be fitted on the top of the well casing to prevent the entry of surface runoff or foreign matter. The well will be completed either: (1) above the ground surface using a locking, steel protective well cover set in concrete; or (2) below the ground surface using a watertight, traffic-rated valve-box with a bolt-down cover. The cover of the valve box will be stamped or cast with "Monitoring Well."

2.2 Piezometer Installation

The piezometer will be designed to register the potentiometric surface of a specific depth zone encountered beneath the drill site. The MFG field geologist, in consultation with the MFG Project Manager, will specify the exact depths of the piezometers using the lithologic log and geophysical log (if performed) for control. Drilling and logging of the boreholes for the piezometers will be in conformance with the MFG SOP entitled SUPERVISION OF EXPLORATORY BORINGS. Construction, completion and development of the piezometers will generally follow the same procedures as those for monitoring wells (see Section 2.0 above), except that a piezometer may be completed with casing material of less than two inches in diameter and may use a porous tip (ceramic or other material) in place of perforated casing.

2.3 Documentation and Records Management

The MFG field geologist will complete a Well Construction Summary form for each monitoring well (Figure SOP-6-1). The completed form will be submitted to the MFG Project Manager and included in the project files. In addition to the information requested on the Well Construction Summary form, the MFG field geologist will record the volumes and types of well construction materials (filter material, bentonite, cement, etc.) used for each well in their field notes. Also, the daily events and other items not covered in the Well Construction Summary form will be entered on a Daily Field Record form in accordance with the procedures contained in the MFG SOP entitled FIELD DOCUMENTATION.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

3.1 Cleaning of Equipment Used in Drilling, Well Construction

The drilling equipment will be thoroughly steam cleaned before and after installation of each monitoring well or piezometer. Only clean, potable water from a municipal supply will be used as makeup water for drilling fluid and for decontamination of drilling equipment. An acid rinse (0.1 N HCl) or solvent rinse (i.e., hexane or methanol) may be used to supplement the steam cleaning if tarry or oily deposits are encountered. Equipment cleaned in this manner will be thoroughly steam cleaned prior to reuse or leaving the site.

Well casing that is not factory cleaned and in a sealed container will be steam cleaned thoroughly before it is installed. This cleaning is particularly critical to prevent cross contamination in a multi-aquifer environment. After cleaning, the casing will be covered with plastic to protect it from contact with dust or other contaminants.

Equipment will be cleaned by scrubbing with a stiff brush using a laboratory-grade detergent/water solution, followed by rinsing with clean, potable, municipal water, then rinsing with distilled or deionized water. Alternatively, the equipment may be steam cleaned followed by rinsing with distilled or deionized water. An acid rinse (0.1 N HCl) or solvent rinse (i.e., hexane or methanol) may be used to supplement these cleaning steps if tarry or oily deposits are encountered. The acid or solvent rinse will be followed by thoroughly rinsing with municipal water and then with distilled or deionized water. After cleaning, equipment will be packaged and sealed in plastic bags or other appropriate containers to minimize contact with dust or other contaminants.

3.2 Records Review

The Project Manager or designated QA reviewer will check and verify that documentation has been completed and filed per this procedure.

WELL CONSTRUCTION SUMMARY

SITE: ____________
PROJECT NO.: ____________

MFG, Inc.

LOCATION: ____________
SUPERVISOR: ____________
PROJECT: ____________
STAFF: ____________

WELL: ____________ COORDINATES: N: ______ E: ______
ELEVATION: GS: ______ TOC: ______ SEC.: ______ T: ______ R: ______

DRILLING SUMMARY:

TOTAL DEPTH: ____________

BOREHOLE DIAMETER: ____________

DRILLER: ____________

RIG: ____________

BIT(S): ____________

DRILLING FLUID: ____________

WELL DESIGN:

BASIS: GEOLOGIC LOG ___ GEOPHYSICAL LOG ___

CASING STRING(S): C=CASING S=SCREEN SND=SAND

MATERIAL(S): CEM=CEMENT BENT= BENTONITE

CASING: C1: ____________
C2: ____________
C3: ____________
C4: ____________

SCREEN: S1: ____________
S2: ____________
S3: ____________

CENTRALIZERS: ____________

FILTER MATERIAL: ____________

CEMENT: ____________

BENTONITE: ____________

CONSTRUCTION TIME LOG:

	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING:				
GEOPHYS.LOG:				
CASING:				
FILTER PACK:				
BENTONITE:				
CEMENTING:				
OTHER:				

DECONTAMINATION:

COMMENTS:

MFG, Inc.

STANDARD OPERATING PROCEDURE No. 7

MONITORING WELL DEVELOPMENT

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the protocol to be followed during the development of groundwater monitoring wells. Monitoring wells must be developed before they are used to collect groundwater samples. The procedures presented are intended to be general in nature. As site-specific conditions become known, appropriate modifications of the procedures may be made when approved in writing by the MFG Project Manager.

2.0 PROCEDURES

2.1 Development Procedure

After construction of the monitoring well is complete, the well will be developed by surging, bailing and/or pumping (e.g., positive displacement hand pump, electric pump or pneumatic pump). At least 24 hours must pass between completion of grouting of the monitoring well and development to allow sufficient curing of the grout.

The total depth of the well will be measured in accordance with the procedures described in the MFG SOP entitled WATER LEVEL, IMMISCIBLE LAYER AND WELL DEPTH MEASUREMENT. The presence of sediment at the bottom of the well will be checked using a stainless steel bailer or positive displacement hand pump. Water and sediment will first be removed from the bottom of the well to ensure that the entire screened interval is open for water to flow into the well. The well should be bailed or pumped until the water removed from the bottom of the well is relatively free of sediment. If a bailer is used, care must be taken to avoid breaking the bottom cap on the well casing.

After most of the sediment has been removed from the bottom of the well, a well development pump (positive displacement hand pump, electric pump or pneumatic pump) should be used to remove water from the well. Initially, the intake of the pump should be at the bottom of the well. The pump intake should be raised in two- to three-foot increments to the top of the water column after approximately one-half of a casing volume of water has been removed from each interval.

Next, a surge block constructed of non-reactive material (usually stainless steel or PVC) should be used to develop the well screen by forcing water in and out of the screened area. The surge block should be moved up and down in one-to two-foot increments creating a suction action on the upstroke and a pressure action on the downstroke. Development should begin at the top of the water column and move progressively downward to prevent the surge block from becoming sand locked. After surging to the bottom of the well, the surge block should be moved progressively upward to the top of the water column.

If necessary, water may be added to the well to facilitate surging. This water should be distilled deionized or "clean" potable municipal water. The volume of de-ionized water added to the well should be noted on the Well Development Record form (Figure SOP-7-1).

After surging, the surge block should be removed and replaced with the pump or bailer. The intake of the pump or bailer should be at the bottom of the well to remove any sediment that may have collected in the bottom of the well. The pump intake should again be raised in two- to three-foot increments to the top of the water column after approximately one-half of a casing volume of water has been removed from each interval.

During development, the pH, specific conductance and temperature of the purge water should be periodically measured and documented on a Well Development Record form. Parameter readings should be collected and noted for every casing volume of water removed from the well.

The well should be alternately surged and pumped until the field water quality parameters have stabilized to within 10% for specific conductance, 0.05 pH units for pH, and 1EC for temperature, and the water is relatively clear and free of sediment.

Water removed during well development should be temporarily stored in steel drums, a portable storage tank or other approved storage container. Final disposal of all water generated during development procedures will be conducted in accordance with all legal requirements and with procedures discussed in the MFG SOP entitled STORAGE AND DISPOSAL OF SOIL, DRILLING FLUIDS, AND WATER GENERATED DURING FIELD WORK.

2.2 Documentation and Records Management

A Well Development Record will be filled out by the MFG Field Geologist for each well developed. The Well Development Record will be submitted to the MFG Project Manager. Also, the daily events and other items not covered in the Well Development Record will be entered on a Daily Field Record form in accordance with the procedures contained in the MFG SOP entitled FIELD DOCUMENTATION.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

3.1 Equipment Cleaning

All reusable equipment used in developing the monitoring well should be cleaned prior to and following use. Cleaning shall be accomplished by either (1) washing with a laboratory-grade detergent/water solution, rinsing with clean, potable, municipal water, then rinsing with distilled or deionized water; or (2) steam cleaning followed by rinsing with distilled or deionized water. An acid rinse (0.1 N HCl) or solvent rinse (i.e., hexane or methanol) may be used to supplement these cleaning steps if tarry or oily deposits are encountered. The acid or solvent rinse will be followed by thoroughly rinsing with water. After final cleaning, equipment will be packaged and sealed in plastic bags or other appropriate containers to minimize contact with dust or other contaminant when not in use.

3.2 Records Review

The Project Manager or designated QA reviewer will check and verify that documentation has been completed and filed per this procedure.

WELL DEVELOPMENT RECORD

WELL NUMBER:

Project No:_______________ Project Name:_______________________________ PAGE ____ of: ____

Date(s): ______________________________

Developed by: ______________________________

Measuring Point (MP) of Well: ______________________

Screened Interval (ft. BGL): ______________________

Filter Pack Interval (ft. BGL): ______________________

Casing Stick-Up/Down (ft.): ______________________

Starting Water Level (ft. BMP): ______________________

Total Depth (ft. BMP): _______Water Column Height (ft.): ______

Casing Diameter (in. ID): _____ Multiplication Factor: _________

Casing Volume (gal.): ______________________

Water Level (ft. BMP) at End of Development: ______________

Total Depth (ft. BMP) at End of Development: ______________

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment:

Development:

Disposal of Discharged Water:

INSTRUMENTS (indicate make, model, i.d.):

Water Level: ______________________ Thermometer: ______________________

pH Meter: ______________________ Field Calibration: ______________________

Conductivity Meter: ______________________ Field Calibration: ______________________

Other: Field Calibration:

DEVELOPMENT MEASUREMENTS

	Purge Characteristics		Water Quality Data				Appearance			
					Specific Conductance (μmhos/cm)					
Date/ Time	Cumul.Vol. (gal)	Water Level (ft. BGL)	Temp. (□C)	pH	@ Field Temp.	@ 25□ C	Color	Turbidity & Sediment	Intake Depth (ft. BMP)	Remarks

Total Discharge (gallons): ______________________ Casing Volumes Removed: ______________________

Observations/Comments:

ABBREVIATIONS:
BMP - below measuring point
BGL - below ground level
Cumul. Vol. - Cumulative volume removed
ID - Inside Diameter
C - Celsius
gal. - gallons
gpm - gallons per minutes
in. – inches

Well Development Form Revision 8/00

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STANDARD OPERATING PROCEDURE No. 10

STORAGE AND DISPOSAL OF SOIL, DRILLING FLUIDS, AND WATER GENERATED DURING FIELD WORK

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the protocol to be followed for the storage, testing, and disposal of soil, drilling fluids, and water generated during any field operations performed by MFG. The procedures presented herein are intended to be of a general nature. Appropriate modifications to the procedures may be made when approved in writing by the MFG Project Manager.

2.0 PROCEDURES

2.1 Material Storage and Labeling

Potentially-contaminated materials will be collected and stored in watertight, secured containers pending determination of their hazards. The containers will be stored temporarily at the site of origin. All steel drums used for storage will be Department of Transportation (DOT)-approved, so that hazardous materials may be transported in these drums if necessary. A daily inventory of the materials generated and the containers in which they are stored will be recorded on the Daily Field Record form. The Daily Field Record is presented in the MFG SOP entitled FIELD DOCUMENTATION.

2.2 Well Purging and Development Water

Water extracted from potentially-contaminated wells or piezometers for the purpose of development, sampling, or hydraulic testing will be stored in sealed, 55-gallon, steel drums or in portable, watertight storage tanks. The containers will be labeled with an indelible marking including the: date; well or piezometer number(s); and "development water" if the water was extracted for development or "purge water" if the water was extracted for sampling or hydraulic testing, in addition to the other labeling requirements included Section 3.0 of this SOP.

2.3 Drilling Fluid

Drilling fluid generated by hydraulic rotary drilling operations will be stored in sealed, 55-gallon, steel drums or in portable, watertight storage tanks. The containers will be labeled with an indelible marking including the: date; boring, well, or piezometer number(s); and "drilling fluid," in addition to the other labeling requirements included in Section 3.0 of this SOP.

2.4 Soil Cuttings

Soil cuttings generated by drilling operations will be stored in sealed, 55-gallon, steel drums or in soil boxes with roll-top, lockable covers. The containers will be labeled with an indelible marking including the: date; boring, well or piezometer number(s); and "cuttings," in addition to the other labeling requirements included in Section 3.0 of this SOP.

2.5 Wash Water

Water used to decontaminate equipment, by steam cleaning or other methods, that was used in potentially contaminated borings, wells or piezometers will be stored in sealed, 55-gallon steel drums or in portable, watertight storage tanks. The containers will be labeled with an indelible marking including the: date; boring, well or piezometer number(s); and "wash water," in addition to the other labeling requirements included Section 3.0 of this SOP.

2.6 Criteria for Hazard Determination

Analyses for hazard determination will be conducted by a laboratory certified by the applicable agency in the state in which the project site is located. Determination of whether the waste is hazardous waste will be based on the criteria in the applicable state and federal regulations.

2.6.1 Drilling Fluid and Cuttings from Exploratory Soil Borings and Well or Piezometer Installation

Evaluation of the hazard status for drilling fluid and cuttings from each boring, well or piezometer may be based upon the results of chemical analyses of the soil and groundwater samples collected from each boring, well or piezometer. Alternatively, representative samples of the drilling fluid and cuttings may be collected and analyzed.

2.6.2 Well Purging and Development Water

Evaluation of the hazard status for well purging and development water from each well or piezometer may be based upon the results of chemical analysis of the groundwater sample subsequently collected from each well or piezometer. Alternatively, representative samples of the purging and development water may be collected and analyzed.

2.7 Labeling

All drums containing waste will be labeled using self-adhesive labels placed on the side of the drums. The labels will be placed in a location on the drum such that the label can be easily read. At a minimum, the following information will be placed on the label using an indelible pen:

- Generator (client) name;
- Drum identification number (when more than one drum present);
- Description of contents, including boring, well or piezometer number(s), as appropriate;
- Date of generation;

- Technical contact (generally the name and phone number of MFG Project Manager); and
- MFG project number.

Local hazardous material storage regulations will also be reviewed for labeling requirements in addition to those listed above.

Appropriate hazardous waste labels will be used when analytical results indicate that the contents are hazardous waste.

2.8 Documentation

All of the information recorded on the drum labels will also be recorded in field notes completed at the work site. This information will be copied to the project file.

3.0 QUALITY CONTROL

3.1 Treatment and Disposal of Contaminated Materials

Soil, drilling fluid and water containing hazardous constituents will be treated and/or disposed of in accordance with all local, state and federal regulations. The appropriateness of on-site treatment versus off-site treatment and/or disposal will be evaluated by the MFG Project Manager based on the hazard determination.

3.2 On-Site Treatment of Contaminated Materials

Soil, drilling fluid, and water of known hazardous composition may be treated on-site provided: (1) such treatment is conducted in accordance with all local, state, and federal regulations based upon location, level of contamination, and volume of material; and (2) permission has been obtained as part of a site access agreement. On-site treatment may be feasible and economical if an on-site soil and/or groundwater treatment system is planned.

3.3 Transport and Disposal of Contaminated Materials

Hazardous waste that requires off-site disposal will be transported by certified hazardous material haulers to approved disposal sites in accordance with state and federal transportation regulations. Soil, drilling fluid, and water which has been classified as hazardous waste based upon the criteria in Section 2.6 of this SOP will be disposed of within 90 days of generation.

MFG, Inc.

STANDARD OPERATING PROCEDURE No. 11

WATER LEVEL, IMMISCIBLE LAYER AND WELL DEPTH MEASUREMENT

1.0 SCOPE AND APPLICABILTIY

This Standard Operating Procedure (SOP) describes the protocol to be followed during measurement of water levels, immiscible layer levels and depths of monitoring wells and piezometers. The procedures presented herein are intended to be general in nature and, as the work progresses and when warranted, appropriate revisions may be made when approved in writing by the MFG Project Manager.

2.0 PROCEDURES

Prior to performing water level, immiscible layer and well depth measurements, the construction details and previous measurements for each well or piezometer shall be reviewed by the MFG field geologist so any anomalous measurements may be identified. Well construction details and previous measurements shall be available in the field for review.

In general, water-level and immiscible-layer depth measurements shall be performed before groundwater is removed from the well by purging or sampling.

2.1 Equipment

Equipment that may be necessary to perform measurements (depending on measurements to be performed):

- Well/piezometer construction details
- Water-level meter
- Water Level Monitoring Record Sheet

- Inteface probe/gas-finding paste/water-finding paste
- Weighted steel surveyor's tape measuring to the nearest 1/10 foot.

2.2 Measuring Point

A measuring point (MP) shall be selected and marked for each monitoring well and piezometer in which water level measurements will be made. Generally, the MP will be the top of the well casing on the north side. The MP will be permanently marked using an indelible marker or a notch cut into the PVC casing. When the top-of-casing elevation of a monitoring well or piezometer is surveyed, the licensed surveyor shall measure the MP elevation and reference this measurement to an appropriate datum (such as feet above mean sea level).

2.3 Water Level Measurements

When water levels are measured to describe the groundwater potentionmetric surface, the water level will be measured prior to purging. All water level measurements will be recorded to the nearest hundredth of one foot. Note the instrument used for each measurement on the Water Level Monitoring Record (Figure SOP-11-1). The measurement procedures to be followed when an immiscible layer is present or suspected in a well are discussed in Section 2.3. Water levels are measured using the electric probe method, as discussed below.

An electric probe consists of a contact electrode attached to the end of an insulated electric cable, and a reel which houses an ammeter, a buzzer, or other closed circuit indicator. The indicator shows a closed circuit and flow of current when the electrode touches the water surface. The electric probes used shall be calibrated periodically by comparing the depth-to-water readings between the electric probe and a steel surveyors' tape. Calibration procedures are discussed in Part B of this section.

The procedure for measuring water levels with an electric probe is as follows:

1. Switch on.

2. Lower the electric cable into the well until the ammeter or buzzer indicates a closed circuit. Raise and lower the electric cable slightly until the shortest length of cable that gives the maximum response on the indicator is found.

3. With the cable in this fixed position, note the depth to water from the Measuring Point (MP).

4. Repeat as necessary until at least two identical duplicate measurements are obtained.

Calibration of the electric probe will be checked at regular intervals as part of regular maintenance measuring the position of the electrode to check that the calibration marks on the electric probe correspond to those on the steel surveyors tape.

2.4 Immiscible Layer Measurement and Sampling

2.4.1 Immiscible Layer Measurement

The thickness of non-aqueous phase liquid (NAPL) in a well may be measured by using (A) an interface probe, (B) gas-finding paste with a water-level meter or (C) water-finding paste with a steel surveyor's tape.

A. Use an interface probe in a similar fashion as an electric water-level probe. An interface probe may be used to measure the thickness of both a light-phase NAPL (LNAPL) and a dense-phase NAPL (sinker). Measure a light-phase NAPL prior to measuring a dense-phase NAPL.

B. Gasoline gauging paste is used for measuring LNAPL (floaters) only. Gasoline gauging paste can be used to detect petroleum hydrocarbons and other LNAPL chemicals. Using a graduated electronic water-level probe, apply a thin layer of gasoline gauging paste (Kolor-kut brand or equivalent) to the amount of tape greater than the anticipated LNAPL thickness. Make a depth to water measurement; probe buzzer/light will activate when it contacts the water (not the LNAPL). Record the depth to water from the MP then quickly reel up the tape. Record level of the LNAPL on the tape by noting where the gasoline gauging paste has changed color. This level will be the thickness of the LNAPL layer.

C. Water-finding paste is used only for LNAPLs . Using a steel surveyor's tape coated with chalk on the bottom foot, take a depth to "liquid" measurement from the measuring point (MP) of the well, as described in Section 2.2. Record the depth to "liquid" measurement. Clean and dry the steel tape and recoat the bottom calibrated foot with fresh chalk. Along one edge of the bottom calibrated foot of the steel tape, apply a thin layer of the yellow water-finding paste (Kolor-Kut brand or equivalent). Take another "depth to liquid" measurement from the MP of the well. Upon retrieving the steel tape, quickly note the depth to "liquid" marked by the wet/dry chalk interface along one edge, and the depth to water marked by the yellow/red paste interface along the other edge. Record the chalk measurement as the depth to "liquid" and the paste measurement as the depth to water. The thickness of the NAPL is the difference between these two measurements. If the two readings are identical, then there is no measurable NAPL in the well.

Record the thickness of the NAPL in the "Remarks" column of the Water Level Monitoring Record (Figure SOP-11-1). To calculate the corrected water level elevation in the presence of LNAPL, use the worksheet provided as Figure SOP-11-2.

If a light-phase NAPL (floater) is not detected using the water-finding paste, gasoline gauging paste or interface probe, but the presence of light-phase NAPL is suspected, the presence of a very thin layer or sheen (too thin to be measured) may also be checked using a bottom-filling transparent bailer. The presence of a light-phase layer is checked by lowering the bailer into the well. Care must be taken to <u>not</u> completely submerge the bailer. Retrieve the bailer and visually examine the air/liquid interface for the presence of an immiscible light-phase layer or sheen. Note that the transparent bailer is not to be used to measure the thickness of light-phase NAPL in a well.

The presence of a dense-phase NAPL (sinker) may also be checked next by lowering the bailer to the base of the well. Retrieve the bailer and visually examine for the presence of an immiscible, dense-phase layer. Note that the transparent bailer is not to be used to measure the thickness of dense-phase NAPL in a well.

2.4.2 Immiscible Layer Sampling

Samples of immiscible layers may be obtained with a bailer (A) or a peristaltic pump (B), if the well is shallow (i.e., depths of about 20 feet or less, depending upon the liquid).

A. Bailer Method -- A appropriate sampling bailer with a ball check valve is submerged to the desired sample depth, either directly or by suspending the bailer on a rope from a pole.

B. Peristaltic Pump Method -- The sample is collected through a section of clean, flexible Tygon (polyvinyl chloride) tubing which will not be reused. The tubing intake will be secured manually or by attaching weights. This procedure may be modified to collect the sample through a Teflon tube into a sample flask by running the pump on a vacuum.

Sample containers prepared specifically for the required analyses by the analytical laboratory or their supplier will be used for sample collection. To collect a sample in a volatile organic analysis (VOA) vial, remove the cap with Teflon-lined septum, then fill slowly (avoiding agitation) until a miniscus of NAPL (held by surface tension) extends above the top of the vial. Carefully replace the cap, then turn the vial upside down and tap gently while checking to ensure that no headspace (air bubbles) is present in the vial.

2.4.3 Sample Handling

Care should be taken to thoroughly clean the outside of the sample bottles that contain the immiscible liquids. To avoid potential cross-contamination, these samples will be kept in a designated ice chest, separate from other groundwater samples. Equipment used in immiscible layer measurement and sampling must be thoroughly decontaminated in accordance with the procedure described in Section 4.0 of this SOP. Samples will be handled in accordance with the procedures described in the MFG SOP entitled SAMPLE CUSTODY.

2.5 Well Depth Measurements

The total depth of a well shall be measured by sounding with a weighted steel surveyors' tape or other steel or fiberglass measuring tape, weighted as needed. For shallow wells, the electronic water-level probe may also be used as a measuring device. Procedures to be followed are specified below.

A. For calibration, measure the distance between the zero mark on the end of the measuring tape and the bottom of the weight to the nearest 1/10 foot at the beginning of each well depth measurement activity day, and whenever the apparatus is altered.

B. Lower a weighted tape into the well until the tape becomes slack or there is a noticeable decrease in weight, which indicates the bottom of the well. Care should be taken to lower the tape slowly to avoid damage to the bottom of the well by the weight. Raise the tape slowly until it just becomes taut, and with the tape in this fixed position, note the tape reading opposite the Measuring Point to the nearest 1/10 foot. Add the values from the distance from the end of the tape to the end of the weight together, round this number to nearest 1/10 foot, and record the resulting value as "well depth below MP" in the "Remarks" column of the Water Level Monitoring Record form.

2.6 DOCUMENTATION AND RECORDS MANAGEMENT

Water levels observed in wells selected for the groundwater level monitoring program will be tabulated on a Water Level Monitoring Record form during each monitoring period (Figure SOP-11-1). The date and time of each measurement will also be recorded on the Water Level Monitoring Record. All water level measurements shall be recorded to the nearest 1/100 foot, and all depth measurements shall be noted to the nearest 1/10 foot.

Water level data will be recorded as feet below measuring point so that water level elevations may be calculated from the depth-to-water measurement (from measuring point) and the surveyed elevation of the measuring point at each well or piezometer.

Well depth measurements may be recorded in the “Remarks” column of the Water Level Monitoring Record.

If free product is encountered during water level measurement, the measured thickness or observation shall be recorded in the "Remarks" column. Each form or, as appropriate, individual measurement data, shall be signed to indicate the originator. If LNAPL is encountered, the corrected water level elevation may be calculated using the procedures included on Figure SOP-11-2.

3.0 QUALITY CONTROL

3.1 Equipment Decontamination/Cleaning

Steel surveyors' tapes, electric well probes, and other measuring tapes shall be cleaned prior to use and after measurements in each well are completed. Cleaning shall be accomplished by either (1) washing with a laboratory-grade detergent/water solution, rinsing with clean, potable, municipal water, then rinsing with distilled or deionized water, or (2) steam cleaning followed by rinsing with distilled or deionized water. An acid rinse (0.1 N HCl) or solvent rinse (i.e., hexane or methanol) may be used to supplement these cleaning steps if tarry or oily deposits are encountered. The acid or solvent rinse will be followed by thoroughly rinsing with municipal water and then with distilled or deionized water. After cleaning, equipment will be packaged and sealed in plastic bags or other appropriate containers to minimize contact with dust or other contaminants.

3.2 Technical and Records Reviews

The project manager or designated QA reviewer will check and verify that documentation has been completed and filed per this procedure.

In addition, all calculations of water-level elevations and NAPL correction to water-level elevations must be reviewed before they are submitted to the project file and used to describe site conditions. The calculation review should be performed by technical personnel familiar with this procedure. Evidence of the completed review and any necessary corrections to calculations should also be submitted to the project file.

WATER LEVEL MONITORING RECORD

WELL LOCATION:

Project No.: ____________ Project Name: ____________________ Page: ______ of ______

Weather Conditions: ____________________

Measuring Point of Well (MP): ____________________

Measuring Device: ____________________

Observations/Comments: ____________________

WELL	DATE/ TIME	MP ELEVATION (feet, NGVD)	DEPTH TO WATER (feet below MP)	CONVERSIONS OR CORRECTIONS TO DEPTH TO WATER	WATER LEVEL ELEVATION (feet, NGVD)	REMARKS	MEASURED BY

Measured by: ____________________

Checked by: ____________________

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Water Levels Form Revision: 8/00

FIGURE SOP-11-1. WATER LEVEL MONITORING RECORD

Project No: ____________________

Task No.: ____________________

By ________ Checked By __________ File No.: ____________________

Date ________ Date __________ Sheet __________ of ________

WORKSHEET
FOR CORRECTION OF WATER LEVEL ELEVATION
IN THE PRESENCE OF
LIGHT NON-AQUEOUS PHASE LIQUID (LNAPL)

Formula: $E_C = E_{MP} - [W_L - (S_{Gp} * T_P)]$

where:

E_C = Corrected water level elevation (feet)

E_{MP} = Measuring point elevation (feet)

W_L = Depth to water (not depth to product) feet below measuring point

S_{Gp} = Specific Gravity of product

Project-specific reference for Specific Gravity of product:

T_P = Thickness of product (feet)

CALCULATIONS:

MFG, Inc.

STANDARD OPERATING PROCEDURE No. 12

WATER QUALITY SAMPLING

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the protocol to be followed during sampling of surface water, groundwater, stormwater or waste water. Note that the protocol for collection of non-aqueous phase liquid (NAPL) samples from monitoring wells is provided in the MFG, Inc. (MFG) SOP entitled WATER LEVEL, IMMISCIBLE LAYER AND WELL DEPTH MEASUREMENT. The procedures presented herein are intended to be general in nature. Appropriate revisions may be made to accommodate site-specific conditions or project-specific protocols when they are approved in writing by the MFG Project Manager or detailed in a project work plan, sampling plan or quality assurance project plan.

2.0 PROCEDURES

2.1 Groundwater Sample Collection

Individual samples from wells will be collected as follows:

A. The depth to water, the thickness or presence of a Non-Aqueous Phase Liquid (NAPL) in a well and the total depth will be measured using the procedures discussed in the MFG SOP entitled WATER LEVEL, IMMISCIBLE LAYER AND WELL DEPTH MEASUREMENT.

B. A positive displacement pump, submersible pump, and/or bailer will be used for removing the groundwater in the monitoring wells (purging). Equipment used for purging and sampling may be permanently installed (dedicated) in the monitoring wells. Care must be taken that bailers and/or tubing are constructed from materials that will not affect the sample analyses.

C. Wells will be pumped or bailed at least until the volume of water removed is equal to three casing volumes (volume of standing water in the well based upon total depth of well, the depth to water, and the well casing diameter). The purge rate must not reach a point where the recharge water is entering the well in an agitated manner. To assure that the water samples are representative of the water-yielding zone, periodic measurements of the temperature, pH, and specific conductance will be made. The sample will be collected only when the temperature, pH and specific conductance reach a relatively constant value (see Section 2.8) or after five well volumes have been removed. If the yield of the well is low such that it can be bailed or pumped dry, then the recharged groundwater in the well will be considered representative regardless of the number of casing volumes of groundwater removed, since all standing water in the well has been replaced by recharge from the water-yielding zone. If a well is purged dry, the well can be sampled upon 90% recovery or after two hours, whichever occurs first.

D. For specific projects, a low-flow purge method or "micopurge" method may be used for sample collection. Wells will be purged at a low pumping rate to minimize agitation of water in the well and minimize drawdown. The goal is to limit drawdown in the well to less than 10 percent of the length of the saturated well screen. If the initial water level is above the top of the screen, then the goal is to limit drawdown due to purging so that the water level in the well does not drop below the top of the screened interval. Wells will be purged by pumping water at a rate less than 250 mL per minute. Bailers will not be used for purging of sampling wells.

E. A sample drawn from plumbing on municipal or domestic wells will be taken at the access valve closest to the well and upstream of any water softening or chlorination input.

F. Prior to collecting samples from a well, a clean plastic apron will be placed adjacent to or around the well to prevent equipment and sample containers from coming into contact with surface materials. Alternatively, a clean field table may be set up near the well. If used, the table will be cleaned (Section 6.0) before and after use at each well.

G. Sample containers prepared specifically for the required analyses by the analytical laboratory or their supplier will be used for sample collection. Samples for volatile organic compound analyses will be collected first. To collect a sample in a volatile organic analysis (VOA) vial, remove the cap with Teflon-lined septum, then fill slowly (avoiding agitation) until a miniscus of sample water (held by surface tension) extends above the top of the vial. Carefully replace the cap, then turn the vial upside down and tap gently while checking to ensure that no headspace (air bubbles) is present in the vial.

Other glass sample bottles for semi- and non-volatile analyses should be filled to near the top. To account for slight expansion due to temperature changes, leave headspace approximately equivalent to the volume of liquid which would fill the bottle's cap. Plastic sample bottles should be filled completely. Splashing of the water in the sample container and exposure to the atmosphere shall be minimized during sampling. The container cap will be screwed on tightly immediately after filling the sample container. Sample filtration, if necessary, is discussed in Section 2.4 of this SOP.

Sample bottles that do not contain preservative should be rinsed with the sample water prior to filling.

H. Where more than one well within a specific field or site is to be sampled, the sampling sequence should begin with the well having the lowest suspected level of contamination. Successive samples should be obtained from wells with increasing suspected contamination. If the relative degree of suspected contamination at each well cannot be reasonably assumed, sampling should proceed from the perimeter of the site towards the center of the site. The sampling sequence should be arranged such that wells are sampled in order of increasing proximity to the suspected source of contamination, starting from the wells up-gradient of the suspected source.

I. Sampling activity for each monitoring well will be recorded on a Groundwater Sampling Record (example attached).

2.2 Surface Water Sample Collection

Individual samples from surface water sampling stations will be collected as follows:

A. Where multiple sampling stations exist along a moving water source (i.e., a creek or drainage channel), the downstream station will be sampled first. A moving water sample will be taken from the portion of the water with maximum flow at any given sampling station unless otherwise specified. If the sampling point is inaccessible from shore, the sampling personnel will enter the water from a point downstream of the sampling point, taking care not to disturb the water.

B. A standing water sample will be taken at a point in the body of water at least three feet from the shore, if possible, or unless otherwise specified.

C. A surface water sample will be collected according to one of the following, or similar, techniques.

1. Direct Method -- Sample bottle is inverted, submerged to the specified depth, turned upright, removed from the water, and then capped. Add preservative, if any, after sample collection.

2. Dipper Method -- Sample bottle or container attached to a pole is dipped in the water, raised above the water, and then capped (if actual sample bottle used).

3. Bailer Method -- A appropriate sampling bailer with a ball check valve is submerged to the desired sample depth, either directly or by suspending the bailer on a rope from a pole.

4. Syringe Method (for very shallow water) -- A disposable plastic filtering syringe may be used to collect very shallow surface water without disturbing the sediment. The syringe will be disposed of after each use.

5. Peristaltic Pump Method -- The sample is collected through a section of new, clean, flexible Tygon (polyvinylchloride) tubing. The tubing intake will be secured manually or by attaching weights. This procedure may be modified to collect the sample through a Teflon tube into a sample flask by running the pump on a vacuum.

D. The first collected water will be used to rinse the sampling equipment. Sample bottles that do not contain preservative should be rinsed with the sample water prior to filling. Subsequent water collected will be used to fill the analytical sample bottles until all bottles are filled. Field measurement of parameters will be taken once for each sampling station. Field parameters (pH, specific conductance, temperature, odor, turbidity, and/or sediment) will be measured from a separate container (instruments will not contact the analytical samples).

E. A stake or pole identifying the sampling station should be placed at or near the sampling station for future identification of the location. MFG personnel will record a brief description of the stake or pole location in relation to permanent landmarks, and the sampling location in relation to the stake or pole (example: stake is approximately 100 feet west along Markley Creek from Somersville Road, on north-side shore. Sampling point is 25 feet south of stake, in middle of Markley Creek). MFG personnel will include a sketch map of the sampling station in the Surface Water Sampling Record (example attached).

2.3 Sample Filtration

When required, a field-filtered water sample will be collected using a disposable, in-line 0.45 µm filter. The water sample will be pumped through the filter using a peristaltic pump and a section of Tygon (polyvinylchloride) tubing or other appropriate method. An aliquot of approximately 100 ml of sample will be run through the tubing and filter prior to collection into the sampling containers. Both the filter and tubing will be disposed of between samples.

2.4 Sample Containers and Volumes

The sample containers will be appropriate to the analytical method and will be obtained from the water analysis laboratory or other approved source. Different containers will be required for specific groups of analytes in accordance with U.S. EPA Methods, project-specific requirements, and/or other local jurisdictional guidance. The MFG sampler will confirm with the laboratory performing the analyses that appropriate bottleware and preservatives are used and ensure that a sufficient volume of sample is collected.

2.5 Sample Labeling

Sample containers will be labeled with self-adhesive tags. Each sample will be labeled with the following information using waterproof ink.

A. Project identification;

B. Sample identification;

C. Date and time samples were obtained;

D. Requested analyses and method;

E. Treatment (preservative added, filtered, etc.); and

F. Initials of sample collector(s).

2.6 Sample Preservation and Storage

If required by the project or analytical method, water samples submitted for chemical analysis will be stored at 4°C in ice-cooled, insulated containers immediately after collection. Preservation and storage methods depend on the chemical constituents to be analyzed and should be discussed with the water analysis laboratory prior to sample collection. EPA and/or other local jurisdictional requirements and/or the requirements of a project-specific plan (e.g., sampling and analysis plan, work plan, quality assurance project plan, etc.) shall be adhered to in preservation and storage of water samples.

2.7 Sample Custody

Samples shall be handled and transported according to the sample custody procedures discussed in the MFG SOP entitled SAMPLE CUSTODY. The sample collector shall document each sample on the Chain-of-Custody and Request for Analysis form (Figure SOP-12-1).

2.8 Field Measurements

Specific conductance, pH, and temperature measurements may be performed on water samples at the time of sample collection. Data obtained from these (or other) field water quality measurements will be recorded on the appropriate sampling records. Separate aliquots of water shall be used to make field measurements (i.e., sample containers for laboratory analysis shall not be reopened).

For groundwater samples, field measurement intervals will be calculated based upon the casing volume of the monitoring well so that at least four readings will be taken during the course of purging the target volume from the well (at least three casing volumes). Note that the target volume criteria does not apply if the well is purged dry. If the parameters have not stabilized after the target volume is removed from the well, field measurements and purging will continue until two consecutive readings have stabilized to within the following limits or until five casing volumes have been removed:

- Specific conductance+/-10%
- pH +/-0.05 pH units
- temperature+/-1EC

For surface water sampling, the parameters will be measured once and recorded.

2.8.1 Temperature Measurement

Temperature will be measured directly from the water source or from a separate sample aliquot. Temperature measurements will be made with a mercury-filled thermometer, bimetallic-element thermometer, or electronic thermistor. All measurements will be recorded in degrees Celsius (°C).

2.8.2 pH Measurement

A pH measurement will be made by dipping the probe directly into the water source or into a separate sample aliquot. Prior to measurement, the container in which the field parameter sample will be collected will be acclimated to the approximate temperature of the sample. This can be accomplished by immersing the container in water removed from a well during the purging process. The pH measurement will be made as soon as possible after collection of the field parameter sample, preferably within a few minutes, using a pH electrode. The value displayed on the calibrated instrument will be recorded after the reading has stabilized. If the value falls outside of the calibrated range, then the pH meter will be recalibrated using the appropriate buffer solutions.

2.8.3 Specific Conductance Measurement

Specific conductance will be measured by dipping the probe directly into the water source or into a separate sample aliquot. The probe must be immersed to the manufacturer's recommended depth. Specific conductance will be reported in micromhos/cm at 25°C. If the meter is not equipped with an automatic temperature compensation function, then the field value will be adjusted at a later time using the temperature data and the following formula:

$$SC_{25} = SC_T / [1 + \{(T - 25) \times 0.025\}]$$

where:
SC_{25} = specific conductance at 25°C
SC_T = specific conductance measured at temperature T (°C)
T = sample temperature (°C)

The value displayed on the calibrated instrument will be recorded after the reading has stabilized. If the value falls outside of the calibrated "range" set by the range dial on the instrument, then the range setting will be changed to a position which gives maximum definition. If the specific conductance value falls outside of the calibrated range of the conductivity standard solution, then the instrument will be recalibrated using the appropriate standard prior to measurement.

2.8.4 Equipment Calibration

Equipment used to measure field parameters will be calibrated by MFG personnel according to manufacturer's instructions. Calibration checks will be performed at least once prior to and at least once following each day of instrument use in the field and the results will be documented on the Sampling Record for each sampling station.

2.9 DOCUMENTATION

2.9.1 Groundwater Sampling Record

Each sampling event for each monitoring well will be recorded on a separate Groundwater Sampling Record form. The documentation should include the following:

A. Project identification;

B. Location identification;

C. Sample identification(s) (including quality control samples);

D. Date and time of sampling;

E. Purging and sampling methods;

F. Sampling depth;

G. Name(s) of sample collector(s);

H. Inventory of sample bottles collected including sample preservation (if any), number, and types of sample bottles;

I. Total volume of water purged;

J. Results of field measurements and observations (time and cumulative purge volume, temperature, pH, specific conductance, turbidity, sediment, color, purge rate);

K. Equipment cleaning record;

L. Description and identification of field instruments and equipment; and

M. Equipment calibration record.

When the sampling activity is completed, the Groundwater Sampling Record will be checked by the MFG Project Manager or his/her designee, and the original record will be placed in the MFG project file.

2.9.2 Surface Water Sampling Record

Each sampling event for each surface water sampling station will be recorded on a separate Surface Water Sampling Record form (Figure SOP-12-2). The documentation should include the following:

A. Project identification;

B. Location identification (sampling station);

C. Sample identification(s) (including quality control samples);

D. Date and time of sampling;

E. Description of sampling location;

F. Sampling depth below water surface;

G. Sampling method;

H. Condition of water (standing or moving);

I. Description of flow measurement method, if applicable, and any flow data;

J. Instrument calibration and cleaning record;

K. Results of field measurements and observations (time, temperature, pH, specific conductance, turbidity, sediment, color);

L. Name(s) of sample collector(s); and

M. Sketch map showing location of sampling station and permanent landmarks.

When the sampling activity is completed, the Surface Water Sampling Record will be checked by the MFG Project Manager or his/her designee, and the original record will be placed in the MFG project file.

3.0 QUALITY CONTROL

3.1 Chain-of-Custody and Request for Analysis Form

A Chain-of-Custody and Request for Analysis form (CC/RA form) will be filled out as described in the MFG SOP entitled SAMPLE CUSTODY. Sample custody procedures are discussed and the CC/RA form presented in the MFG SOP entitled SAMPLE CUSTODY, PACKAGING AND SHIPMENT.

3.2 Equipment Cleaning

Sample bottles and bottle caps will be cleaned and prepared by the analytical laboratory or their supplier using standard EPA-approved protocols. Sample bottles and bottle caps will be protected from dust or other contamination between time of receipt by MFG and time of actual usage at the sampling site.

Groundwater sampling equipment may be dedicated to a particular well at a project site. Prior to installation of this equipment, all equipment surfaces that will be placed in the well or may come in contact with groundwater will be cleaned to prevent the introduction of contaminants (refer to the MFG SOP entitled EQUIPMENT DECONTAMINATION).

Sampling equipment that will be used at multiple wells or sampling locations will be cleaned after sampling at each location is completed in accordance with the MFG SOP entitled EQUIPMENT DECONTAMINATION.

Equipment such as submersible electric pumps, which cannot be disassembled for cleaning, will be cleaned by circulating a laboratory-grade, detergent and potable water solution through the assembly, followed by clean potable water from a municipal supply, and then by distilled or deionized water. Equipment cleaning methods will be recorded on the Groundwater Sampling Record and Surface Water Sampling Record.

3.3 Records Review

The MFG Project Manager or designated QA reviewer will check and verify that documentation has been completed and filed per this procedure.

GROUNDWATER SAMPLING RECORD

WELL NUMBER:

PAGE: ____ of ____

Project No :__________ Project Name: ______________________________ Date: __________

Sampling Location (well ID, etc.): ____________________

Sampled by: ____________________

Measuring Point (MP) of Well: ____________________

Screened Interval (ft. BGL): ____________________

Filter Pack Interval (ft. BGL): ____________________

Casing Stick-Up/Down (ft.): ____________________

Starting Water Level (ft. BMP): ____________________

Total Depth (ft. BMP):________Water Column Height (ft.):________

Casing Diameter (in. ID):________ Multiplication Factor: ________

Casing Volume (gal.):______ 2X _______ 3X _______ 4X _______

Water Level (ft. BMP) at End of Purge: ____________________

Total Depth (ft. BMP) at End of Purge: ____________________

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: ____________________

Purging: ____________________ Sampling: ____________________

Disposal of Discharged Water: ____________________

INSTRUMENTS (indicate make, model, i.d.):

Water Level: ____________________ Thermometer: ____________________

pH Meter: ____________________ Field Calibration: ____________________

Conductivity Meter: ____________________ Field Calibration: ____________________

Other: Field Calibration:

SAMPLING MEASURMENTS

	Purge Characteristics		Water Quality Data				Appearance			
					Specific Conductance (µmhos/cm)					
Date/ Time	Cumul.Vol. (gal)	Purge Rate (gpm)	Temp (°C)	pH	@ Field Temp.	@ 25 °C	Color	Turbidity & Sediment	Intake Depth (ft. BMP)	Remarks

SAMPLE INVENTORY

Water Level (ft. BMP) Before Sampling: __________ Recovery %: __________ Sample Intake Depth (ft. BMP): __________

Bottles Collected							
Date/ Time	Sample ID	Container (glass, plastic)	Quantity/ Vol.	Filtered (Y/N)	Preserved (type)	Analysis	Remarks (natural, dups, blanks, QC)

Chain-of-Custody Record No. ____________________

ABBREVIATIONS:
BMP = below measuring point
BGL = below ground level
Cumul.Vol. = Cumulative volume removed
ID = Inside Diameter
C = Celsius
gal = gallons
gpm = gallons per minute
in. = inches

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GW Sample Form Revision: 8/00

FIGURE SOP-12-1. GROUNDWATER SAMPLING RECORD

SURFACE WATER SAMPLING RECORD

LOCATION NUMBER:

Project No:______________ Project Name:______________________________ Page _____ of: _______

Sampled by:____ Date: ________________

Weather (when sampling): ____________________ Weather (past 48 hrs.) ________________________

Sampling Location (ID, description): ____

Water Body (describe type, flow):

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: ____

Sampling:____

INSTRUMENTS (indicate make, model, i.d.):

Flow Measurement: ______________________ Thermometer: ____________________________

pH Meter: ______________________________ Field Calibration: _________________________

Conductivity Meter: ______________________ Field Calibration: _________________________

Filtration: *Other:*

SAMPLING MEASUREMENTS

		Water Quality Data				Appearance		
				Specific Conductance (µmhos/cm)				
Time	Sampling Depth (ft.)	Temp. (°C)	pH	@ Field Temp.	@ 25° C	Color	Turbidity & Sediment	Remarks (debris, sheen, etc.)

Flow @ Sampling Point (units): Total Depth @ Sampling Point (Ft.):

SAMPLE INVENTORY

Bottles Collected							
Date/Time	Sample ID	Container (glass, plastic)	Quantity/ Vol.	Filtered (Y/N)	Preserved (type)	Analysis	Remarks (*natural, dups, blanks, QC*)

SAMPLING LOCATION MAP

(reference permanent landmarks, indicate scale, approx. North, direction of flow)

Chain-of-Custody Record No.

ABBREVIATIONS:

ft. – feet
cfs – cubic feet per second
gpm – gallons per minute
C - Celsius
gal. - gallons

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STANDARD OPERATING PROCEDURE No. 14

HYDRAULIC TESTING

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the protocol to be followed during performance of a constant-discharge pumping test or a "slug test." The procedures presented herein are intended to be general in nature; as the work progresses and when warranted, appropriate revisions may be made when approved in writing by the MFG Project Manager.

2.0 PROCEDURES

2.1 Constant-Discharge Test

The performance of a constant-discharge pumping test involves three phases: 1) pre-test measurements; 2) pumping portion of the test; and 3) recovery portion of the test. Pre-test measurements include water level measurements which indicate water level trends in the test area. These effects must be accounted for when test data are analyzed. The pumping portion of the test involves monitoring water levels in the pumping well and observation wells while the discharge in the pumping well is kept fairly constant. Groundwater samples may be collected during this phase. The recovery portion of the test occurs after pumping is stopped and involves the measurement of recovery water levels in the pumped well and observation wells.

2.1.1 Pre-Test Measurements

2.1.1.1 Water Level Measurements

Prior to conducting a pumping test, water level measurements should be taken in the pumped well and all observation wells (other monitoring wells and piezometers) to be monitored during the test to describe the pre-test potentiometric surface and its natural variability (refer to MFG SOP entitled WATER LEVEL, IMMISCIBLE LAYER AND WELL DEPTH MEASUREMENT). Measurements in both the pumped well and observation wells should be taken at least every 4 hours for a minimum of three days before the pumping test begins. More frequent water level measurements in one or more wells using a continuous recording device may be used to substitute for the 4-hour measurement requirement in the pumped well and all observation wells.

Prior to beginning the pumping test, watches, the datalogger and other timing devices to be used in the test should be synchronized.

The water level measurements will be made with an electric water level probe, steel surveyors' tape or continuous recording device (Stevens recorder or pressure transducer/recorder). Accuracy of water level measurements prior to and during the aquifer test will be to within plus or minus 0.02-foot in the observation wells.

An observation well may be monitored continuously with a Stevens Type F water level recorder or a pressure transducer/recorder.

If water levels are measured by hand, all pre-test water level measurements for the pumping well and observation wells will be recorded on a Pumping Test Record form (Figure SOP-14-1). The same form will be used during the pumping portion of the pumping test.

2.1.1.2 Barometric Measurements

A record of barometric changes in the vicinity of the pumping test site shall be obtained for the pre-test and test period. This record will be used to monitor changes in water levels caused by barometric effects. A recording barograph or record from a nearby weather station is acceptable.

2.1.2 Pumping Portion of Test

2.1.2.1 Measurements to be Taken

During the pumping portion of the pumping test, the following measurements will be made: 1) water levels in both the pumped well and the observation wells; 2) instantaneous and cumulative discharge from the pumped well; and 3) time at which these measurements are made. Samples of the discharge water may also be collected periodically during the test for chemical analysis or field testing. All data will be recorded on the Pumping Test Record form (Figure SOP-14-1) for the appropriate well.

2.1.2.2 Water Levels

Pumped Well:

The water level measurements in the pumped well should be taken according to the time schedule outlined below. More frequent measurements may be used.

Time Since Pumping Started	Time Intervals
0 - 10 minutes	0.5 - 1 minute
10 - 15 minutes	1 minutes
15 - 60 minutes	5 minutes
60 - 300minutes	30 minutes
300 - 1440 minutes	60 minutes
1440 - shut down of pump	480 minutes (8 hours)

Observation Wells:

Stevens Type F continuous recorders or pressure transducer/datalogger may be installed in the observation wells. Water level measurements may be taken in these wells using an electric water level probe or steel surveyors' tape for calibration when the Stevens recorder or transducer/recorder is installed, and whenever the recorder chart paper is changed or the recorder is adjusted in any way. If a continuous recorder or pressure transducer/datalogger is not used, then water level measurements may be taken using an electric water level probe or steel surveyor's tape according to the following schedule:

Time Since Pumping Started			Time Intervals
0	-	60 minutes	1 minute
60	-	120 minutes	5 minutes
120	-	240 minutes	10 minutes
240	-	360 minutes	30 minutes
360	-	1440 minutes	60 minutes
1440	-	shut down of pump	480 minutes (8 hours)

The time of measurements and water level measurement will be entered in the appropriate columns of the Pumping Test Record form (Figure SOP-14-1) for the pumped well and observation wells. If a Stevens recorder or pressure transducer/recorder is used, water level calibration and pertinent notes will be entered on the Pumping Test Record form.

2.1.2.3 Discharge Rate

Discharge from the pumped well will be measured using either of the following methods: 1) totalizing flow meter and stopwatch; 2) circular orifice meter; 3) Venturi meter; 4) Parshall flume; or 5) calibrated container and stopwatch. The discharge reading and time of reading will be entered on the Pumping Test Record form for the pumped well.

Discharge should be maintained within plus or minus 5 percent of the designated rate by means of a globe valve or other throttling device. Discharge will be checked and adjusted, if necessary, every 10 minutes during the first hour of pumping, at 30-minute intervals for the following 5 hours, and at one-hour intervals thereafter. Time of measurement and rate of discharge will be entered on the Pumping Test Record form for the pumped well (Figure SOP-14-1). If the pump is driven directly by an engine, the engine speed (in RPM) should be checked and noted every hour during the test. If the pump is run by an engine or a generator, the fuel level and the oil level in the engine or generator will have to be checked periodically, and fuel and/or lubricating oil added when necessary.

2.1.3 Sampling of Discharge Water

Samples of discharge water from the pumped well may be collected at time intervals specified by the MFG Project Manager, provided such sampling does not interfere with water level measurements. The temperature, pH, and specific conductance of the samples will be measured in the field when the samples are collected. The samples will be preserved for subsequent chemical analysis by an authorized laboratory in accordance with the MFG SOP entitled WATER QUALITY SAMPLING. The time the samples were collected and field measurements of water quality parameters will be recorded on the Pumping Test Record form (Figure SOP-14-1) for the pumped well.

2.1.4 Duration of Pumping

The target duration of the pumping portion of each pumping test will be established prior to beginning the test. During the test, time-drawdown and/or distance-drawdown curves for the observation wells may be plotted on semi-logarithmic paper to assist in evaluating if the test is running well and deciding on the time that the pump should be shut off. If the plots indicate steady-state conditions (e.g., the interception of a recharge source), the test may be ended before its target duration. The pumping portion of the test may be extended, at the discretion of the MFG Project Manager, to evaluate hydrologic boundaries or other transient conditions.

2.1.5 Aborted Test

Failure of pumping operations for a period greater than one (1) percent of the elapsed pumping time will require suspension of the test until the water level measured in the pumped well has recovered to within two (2) percent of the total drawdown in the pumped well during pumping. Recovery in the pumped well will also be considered complete after the well has not been stressed for a period at least equal to the elapsed pumping time of the aborted test, or if any three successive water level measurements, at least 30 minutes apart, show no further rise in the water level in the pumped well. When recovery is complete, the pumping portion of the test may be resumed.

2.1.6 Recovery Portion of Test

After the pumping portion of the test has been completed, the pump will be shut off. Water level measurements will then be taken in the pumped well and observation wells in accordance with the schedule presented below:

Time Since Pumping Stopped			Time Intervals	
0	-	15 minutes	1	minute
15	-	60 minutes	5	minutes
60	-	300 minutes	30	minutes
300	-	1440minutes	60	minutes
1440	-	End of test	480	minutes (8 hours)

Water level measurements will continue in the pumped well and observation wells until the water level in the pumped well has recovered to its pre-pumping level, or until a length of time equal to the pumping period has elapsed.

The water level data (water level below MP) and time at which measurement is made for each well will be entered on a Pumping Test Record form (Figure SOP-14-1), using the columns for the recovery portion of the test.

2.1.7 Pump Discharge

The water discharged from the pumped well should be prevented from entering the water-yielding zone being tested. If concentrations of chemicals in the discharged water are suspected to be above regulatory limits for discharge to natural water courses, the water from the pumped well shall be collected for appropriate treatment and/or disposal.

2.2 Slug Tests

Falling-head or rising-head permeameter tests ("slug tests") may be performed on piezometers and monitoring wells to estimate the lateral hydraulic conductivity of the water-bearing strata. Although the radius of influence (i.e., portion of the water-yielding zone tested) is smaller for a slug test than for long-term pumping tests, this testing method is often selected due to the low productivity and/or small available drawdown in wells. Another important consideration is that many locations can be evaluated with the slug test method for the same level of effort and cost of one pumping test.

2.2.1 Testing Equipment

A slug test consists of instantaneously raising or lowering the water level in a well and then monitoring the change of the water level through time. The slug tests will be performed by rapidly submerging (slug-in test) or retracting (slug-out test) a slug of known volume. A typical slug used in 2-inch wells is constructed of a sealed, 1-inch diameter, stainless steel pipe. The displacement volume of the slug will be measured prior to the test program.

A pressure transducer with an appropriate operating range will be used to measure the water levels during the slug tests. The pressure readings will be recorded and converted to feet of water above the transducer using a datalogger. The datalogger is programmed to record the water levels at one-second intervals at the beginning of a test and to logarithmically increase the sampling interval to several minutes toward the end of the test.

2.2.2 Testing Procedure

Upon arrival at a test well site, the static water level and total depth of the well will be measured with an electric water level probe or steel surveyors' tape (see the MFG SOP entitled WATER LEVEL, IMMISCIBLE LAYER AND WELL DEPTH MEASUREMENT). The pressure transducer is then secured in the well to a depth below the lowest point to which the slug will be lowered. Before starting the test, sufficient time will be allowed for the water level in the well to adjust to the displacement caused by the transducer and cable, and for the transducer to equilibrate to the water temperature. During this period, the water level in the well will be monitored electronically using the datalogger and measured periodically with the electric water level probe or steel surveyors' tape to confirm that static water level conditions exist. Next, the slug will be lowered to a point just above the water level in the well and then rapidly submerged to begin the test.

As data are collected, the water levels displayed by the datalogger will be examined to monitor trends and the progress of the test. Manual water level measurements also will be taken during the test to confirm the transducer readings. Each test will proceed until the water level attains at least 95 percent recovery from the slug displacement. Following completion of the slug-in test, a slug-out test will be performed by rapidly pulling the slug out of the water and monitoring the recovery of water level in the same manner as for the slug-in test. In some cases, more than one slug-in and/or slug-out test may be performed to provide additional confirmation of the results.

2.2.3 Equipment Decontamination

Prior to the first slug test and between each test, the slugs, transducer, cable and water level probe (or steel tape) will be decontaminated in accordance with MFG SOP entitled EQUIPMENT DECONTAMINATION.

2.3 Data Analysis

2.3.1 Data Processing

The data collected by the datalogger are stored in the memory of the datalogger and then transferred to a cassette tape or to a computer in the field. If not transferred directly to a computer, these data are subsequently transferred to a computer for field data quality checks and data analysis. When transferred to computer, the data sets are transferred to files in comma-delineated ASCII format. The contents of each data file are imported to a spreadsheet program which allows the data manipulation and graphical presentation needed to calculate the hydraulic parameters of the water-yielding zone.

2.3.2 Slug Test Data Analysis

Slug tests in confined zones will be analyzed primarily by the method described by Cooper, Bredehoeft and Papadopulos (1967), whereas slug tests in semi-confined to unconfined water-yielding zones will be analyzed by the method discussed by Bouwer and Rice (1976). The Bouwer and Rice (1976) method is also applicable to confined aquifers and may be used to compare the results of the Cooper et al. (1967) method for confined aquifers.

Summary of Cooper, Bredehoeft and Papadopulos Method

Cooper et al. (1967) derived a solution using a partial differential equation for radial flow for the response of a finite-diameter well to an instantaneous "slug" of water. The method of analysis involves plotting the results of the slug test as H/H_0 versus log t (time), where:

H = head inside the well above or below the initial head at time t after injection or removal of the slug.

H_0 = head inside the well above or below the initial head at the instant of injection or removal of the slug.

The slug test plot is then compared against a set of "Type Curves" derived and published by Cooper et al. (1967) and Papadopulos, Bredehoeft and Cooper (1973), using a curve matching method, such that curves are moved parallel to H/H_0 to match each other. When the best match between the data plot and type curves is obtained, a value of t is selected at the $Tt/r_c^2 = 1$ match point. The transmissivity (T) is then calculated using the following equation:

$$T = \frac{r_c^2}{t}$$

where: r_c = radius of the well casing.

The hydraulic conductivity (K) is obtained from the T value by:

$$K = \frac{T}{b}$$

where: b = thickness of water-yielding zone.

This method assumes that the water-yielding zone is homogeneous, isotropic, and of uniform thickness, and that the tested well is screened throughout the thickness of the water-yielding zone.

Summary of Bouwer and Rice Method

Bouwer and Rice (1976) presented a procedure for analysis of slug test data from an unconfined aquifer. Based on an electrical analog, Bouwer and Rice provided a convenient set of curves relating the effective radius (R_e) to the other well dimensions. This procedure is based on a modification of the Theim equation for steady state groundwater flow.

$$K = \frac{r_c^2 \ln(R_e / r_w)}{2L} \frac{1}{t} \frac{\ln^{Y_0}}{Y_t}$$

where:

K	=	Hydraulic conductivity
L	=	Screen length
Y_o	=	Head of water at time (o)
Y_t	=	Head of water at time (t)
t	=	Time
r_c	=	Inside radius of casing
r_w	=	Radius of casing plus thickness of filter pack
R_e	=	Effective radius (value of R_e obtained from the set of curves given by Bouwer and Rice)

This method estimates the hydraulic conductivity without calculating transmissivity. The results of the slug tests are plotted as a semi-logarithmic graph of Y_t versus t. The values of Y_t, Y_0, and t are obtained from the straight-line portion of the graph, and the value of K is calculated.

If the water level fluctuates within the screened interval or below the base of the bentonite seal in the well, the following correction will be made to include the porosity of the filter pack in the cross-sectional area of the well (Bouwer and Rice (1976)):

$$r_c = \left\{r^2 + n\left(R^2 - r^2\right)\right\}^{0.5}$$

where:

r_c	=	radius of the well including estimated filter pack porosity
r	=	radius of the well screen
n	=	estimated porosity of the filter pack
R	=	radius of the bore hole

3.0 QUALITY ASSURANCE

3.1 Calculation Check

All data and calculations recorded on the Pumping Test Record will be reviewed prior to use. The reviewer will be a technically qualified hydrologist or hydrogeologist, as designated by the MFG Project Manager. Record of the calculation review will be made by the reviewers initials and date of review on the original Pumping Test Record form.

3.2 Records Review

The project manager or designated QA reviewer will check and verify that documentation has been completed and filed per this procedure.

4.0 REFERENCES

Bouwer, Herman and R. C. Rice, 1976. *A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells*. Water Resource Research, Vol. 12, No. 3, pp. 423-428, June.

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PUMPING TEST RECORD

☐ OBSERVATION WELL _____
☐ PUMPING WELL __________

PAGE _____ OF ______

PROJECT AND LOCATION				PROJECT NO.	ELEVATION AND DATUM
PUMPING WELL		OBSERVATION WELL		TIME STARTED	TIME FINISHED
RADIUS	DEPTH	DEPTH	DISTANCE (OBS TO PUMP)	MEASURING POINT (MP)	CASING HEIGHT
PUMP SETTING	ORIFICE SIZE	RECORDER		CONTRACTOR	
PUMP				FOREMAN	
ELECTRICAL EQUIPMENT				INSPECTOR	

					WATER LEVEL DATA			PUMPING DATA				WATER QUALITY			
DATE AND TIME	TIME SINCE START OF PUMPING, t (MIN)	t/R^2 (DAY/FEET^2)	TIME SINCE PUMPING STOPPED, t' (MIN)	RATIO t/t'	WATER LEVEL BELOW MP (FEET)	DRAWDOWN, s (FEET)	RESIDUAL DRAWDOWN, s' (FEET)	ORIFICE MANOMETER READING (INCHES)	INSTANT DISCHARGE (BY) (GPM)	CUMULATIVE DISCHARGE (BY) (GAL)	ENGINE SPEED (RPM)	TEMPERATURE (□C)	pH	SPECIFIC CONDUCTANCE	REMARKS

WELL:

Pumping Test Record   Revision 8/00

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FIGURE SOP-14-1. PUMPING TEST RECORD (Page 1 of 2)

PUMPING TEST RECORD

☐ OBSERVATION WELL ____
☐ PUMPING WELL ________

PROJECT:	PROJECT NO.	PUMPING WELL	OBSERVATION WELL

					WATER LEVEL DATA			PUMPING DATA				WATER QUALITY			
DATE AND TIME	TIME SINCE START OF PUMPING, t (MIN)	t/R^2 (DAY/FEET^2)	TIME SINCE PUMPING STOPPED, t' (MIN)	RATIO t/t'	WATER LEVEL BELOW MP (FEET)	DRAWDOWN, s (FEET)	RESIDUAL DRAWDOWN, s' (FEET)	ORIFICE MANOMETER READING (INCHES)	INSTANT DISCHARGE (BY) (GPM)	CUMULATIVE DISCHARGE (BY) (GAL)	ENGINE SPEED (RPM)	TEMPERATURE (□C)	pH	SPECIFIC CONDUCTANCE	REMARKS

WELL:

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(303) 447-1823
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FIGURE SOP-14-1. PUMPING TEST RECORD (Page 2 of 2)

MFG, Inc.

STANDARD OPERATING PROCEDURE No. 16

EQUIPMENT DECONTAMINATION

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes the methods to be used for the decontamination of all reusable field equipment which could become contaminated during use or during sampling. The equipment may include split spoons, bailers, trowels, shovels, hand augers or any other type of equipment used during field activities.

Decontamination is performed as a quality assurance measure and a safety precaution. It prevents cross contamination between samples and also helps to maintain a clean working environment.

Decontamination is achieved mainly by rinsing with liquids which may include: soap and/or detergent solutions, tap water, distilled weak acid solution, and/or methanol or other solvent. Equipment may be allowed to air dry after being cleaned or may be wiped dry with chemical-free towels or paper towels if immediate re-use is necessary.

At most project sites, decontamination of equipment that is re-used between sampling locations will be accomplished between each sample collection point. Waste produced by decontamination procedures, including waste liquids, solids, rags, gloves, etc., should be collected and disposed of properly, based upon the nature of contamination. Specific details for the handling of decontamination wastes are addressed in the MFG SOP entitled STORAGE AND DISPOSAL OF SOIL, DRILLING FLUIDS AND WATER GENERATED DURING FIELD WORK or may be specified by a project plan.

2.0 PROCEDURES

2.1 Responsibilities

It is the responsibility of the field sampling coordinator to ensure that proper decontamination procedures are followed and that all waste materials produced by decontamination are properly managed. It is the responsibility of the project safety officer to draft and enforce safety measures which provide the best protection for all persons involved directly with sampling and/or decontamination.

It is the responsibility of any subcontractors (i.e., drilling contractors) to follow the proper, designated decontamination procedures that are stated in their contracts and outlined in the Site-Specific Health and Safety Plan. It is the responsibility of all personnel involved with sample collection or decontamination to maintain a clean working environment and ensure that any contaminants are not negligently introduced to the environment.

2.2 Supporting Materials

1. Cleaning liquids: soap and/or detergent solutions (Alconox, etc.), tap water, distilled water, methanol, weak nitric acid solution, etc.
2. Personal protective safety gear as defined in the Site-Specific Health and Safety Plan.
3. Chemical-free towels or paper towels.
4. Disposable, nitrile gloves.
5. Waste storage containers: drums, boxes, plastic bags, etc.
6. Cleaning containers: plastic and/or stainless steel pans and buckets.
7. Cleaning brushes.
8. Aluminum foil.

2.3 Methods

The extent of known contamination will determine the degree of decontamination required. If the extent of contamination cannot be readily determined, cleaning should be done according to the assumption that the equipment is highly contaminated. Decontamination procedures should account for the types of contaminants known or suspected to be present. In general, high levels of organic contaminants should include an organic solvent wash step, and high levels of metals contamination should include a weak acid rinse step.

The procedures listed below constitute the full field decontamination procedure. If different or more elaborate procedures are required for a specific project, they may be specified in sampling and analysis or work plan. Such variations in decontamination protocols may include all, part or an expanded scope of the decontamination procedure stated herein.

1. Remove gross contamination from the equipment by dry brushing, and rinse with tap water.

2. Wash with soap or laboratory-grade detergent solution.

3. Rinse with tap water.

4. Rinse with methanol (optional, for equipment potentially contaminated by organic compounds).

5. Rinse with acid solution (optional, for equipment potentially contaminated by metals).

6. Rinse with distilled or deionized water.

7. Repeat entire procedure or any parts of the procedure as necessary.

8. Air dry.

Decontaminated equipment should be stored in sealable containers, such as Ziplock-type plastic bags or cases or boxes with lids.

2.4 DOCUMENTATION

Field notes will be kept describing the decontamination procedures followed. The field notes will be recorded according to procedures described in the MFG SOP entitled FIELD DOCUMENTATION.

3.0 QUALITY CONTROL

To assess the adequacy of decontamination procedures, field rinsate blanks may be collected. The specific number of rinsate blanks will be defined in a sampling and analysis or work plan or by the MFG project manager. In general, at least one field rinsate blank should be collected per sampling event or per day.

Rinsate blanks with elevated or detected contaminants will be evaluated by the Project Manager, who will relay the results to the site workers. Such results may be indicative of inadequate decontamination procedures that require corrective actions (e.g., retraining).

MFG, Inc.

STANDARD OPERATING PROCEDURE No. 20

DATA EVALUATION

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) describes a protocol for the evaluation of results generated through laboratory analysis of environmental samples. Included in this protocol are procedures to evaluate the completeness, accuracy and precision of data. The data evaluation procedure provided herein may be used to evaluate data quality with respect to project-specific quality objectives or goals. The quality control limits specified by project depend on the data uses and resultant data quality objectives. This SOP generally follows validation guidelines established by the EPA, however it is not meant to be used if an alternative validation protocol, such as USEPA National Functional Guidelines for Organic Data Review, is specified as required for a project.

A project's Quality Assurance Project Plan (QAPP) and/or other planning documents (e.g., Work Plan, Sampling and Analysis Plan, etc.) must be reviewed before this SOP is used to evaluate data. The individual performing the data evaluation shall be familiar with the analytical methods and other procedures used for that project. Familiarity with laboratory quality control requirements for the analyses performed and a project's reporting/documentation requirements is also necessary before this procedure may be used.

2.0 PROCEDURES

A Data Evaluation Checklist is attached to this SOP. This form, or a similar project-specific form, should be completed to document the data evaluation process and summarize the evaluation results. The procedures for completing the attached Data Evaluation Checklist are as follows:

1. Review project planning documents (e.g., sampling and analysis plan, quality assurance plan) and note the planned analysis methods, detection limits, quality control samples and quality control limits specified for each sample type.

2. Check to see if copies of the Chain-of-Custody records (COCs) are present. If present, verify that all necessary information was provided on each COC and that all necessary signatures are present. Verify that all samples listed on the COCs were analyzed for the appropriate parameters. Note any problems written on the COCs by either the laboratory or the sampler.

3. Briefly summarize the laboratory's narrative, if present. If notes or comments were written on individual data pages, summarize these also.

4. Review temperature and preservation information to verify that samples were properly preserved.

5. For each sample and each parameter, verify that the analyses were performed within the appropriate holding time. If the specific dates of analysis are not provided, check the date the report was issued. This may be helpful if the report date is within the sample holding times (i.e., most metals have a 6-month hold time, and reports are usually issued prior to 6 months indicating the analyses were performed within hold times).

6. Verify that the field QC samples specified in the Work Plan, SAP or QAPP for the project have been collected at the correct frequency.

7. Review the results of all blanks, including field QC samples (equipment blanks, trip blanks) and laboratory method blanks. If an analyte was detected in a blank, check to see if any sample results associated with that blank were within five times the blank concentration. If an associated sample result is less than five times the blank concentration, the result is potentially biased high and may be considered non-detect. If an analyte is detected in the method blank and another type of blank, first apply this five times rule using the method blank concentration. This may result is the other blank being considered non-detect due to method blank contamination.

8. Check the matrices, units and detection or reporting limits for each result to verify that they are reported correctly and meet any project-specific requirements. Contact the laboratory regarding any discrepancies.

9. If organic analyses were performed, check the surrogate recoveries for each sample to ensure that the recoveries were within the laboratory's control limits. If a surrogate recovery is outside of the control limits, the associated sample data may be biased and should be considered estimated results.

10. Review all LCS (and LCSD if available) recoveries and verify that they were within the project-specified control limits. If project-specific control limits are not provided, use the method control limits or laboratory's control limits. If an LCS recovery was above the control limits, the associated data are potentially biased high, and if the LCS recovery was below the control limits the associated data are potentially biased low. If an LCS and an LCSD were analyzed, compare the LCS/LCSD RPD to the appropriate control limit. An RPD outside of the control limits indicates poor analytical precision. LCS recoveries and LCS/LCSD RPDs outside of control limits should be discussed with the laboratory so that they can take corrective actions.

11. Review all MS (and MSD if available) recoveries and verify that they were within the project-specified control limits. If project-specific control limits are not provided, use the method control limits or laboratory's control limits. If an MS recovery was above the control limits the associated data are potentially biased high due to matrix effects, and if the MS recovery is below the control limits the associated data are potentially biased low due to matrix effects. MS recoveries consistently outside of control limits should be discussed with the lab to determine if corrective actions are necessary. If an MS and an MSD were analyzed, compare the MS/MSD RPD to the appropriate control limit. An RPD outside of the control limits indicates poor precision for the matrix type (e.g., surface water).

12. If an analytical duplicate was analyzed, calculate the RPD and compare this to the project-specified control limits. If a project-specific control limit is not available, use the method control limits or the laboratory's control limits. However, if one or both of the results are less than five times the detection limit, used ± 2 times the detection limit as the control limit. If an RPD is outside of the control limits, the associated data should be considered estimated values due to poor analytical precision.

13. If field duplicates were analyzed, calculate the RPD for each parameter and compare the RPDs to project-specified control limits. If project-specific control limits are not available, use 30 percent for aqueous samples and 50 percent for soil samples. However, if one or both of the results are less than five times the detection limit, use ± 2 times the detection limit as the control limit. If an RPD is outside of the control limits, the associated data should be considered estimated due to poor field and/or analytical precision.

14. Calculate the project completeness (see Section 4.0). Compare this number to the project completeness goal.

15. Comments: Provide a brief summary of the accuracy, precision and completeness of the data set, including a discussion of data usability. Definitions of accuracy, precision and completeness are provided in Section 4.0. Discuss any QC that is outside of the specified control limits and identify any samples that have been affected.

2.1 Documentation

A Data Evaluation Checklist (attached), or similar form, should be completed to document the evaluation process and evaluation results. These checklists should be provided to the MFG Project Manager and included in the project's laboratory results file.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

Definitions of accuracy, precision and completeness and methods for computing their measures are provided below. Calculations should be checked by an independent reviewer.

3.1 Accuracy

Accuracy is the degree of difference between the measured or calculated value and the true value. Data accuracy or analytical bias is often evaluated by the analysis of surrogate standards for organic analyses, and laboratory control samples (LCS) and matrix spike (MS) samples for organic and inorganic samples, with results expressed as a percentage recovery measured relative to the true (known) concentration. The percentage recovery for surrogate standards and LCS samples is given by:

$$\text{Recovery (\%)} = \frac{A}{T} \times 100$$

where: A = measured concentration of the surrogate or LCS; and
T = known concentration.

The percentage recovery for MS samples is given by:

$$\text{Recovery (\%)} = \frac{A - B}{T} \times 100$$

where: A = measured concentration of the spiked sample;

B = concentration of unspiked sample; and

T = amount of spike added.

Blanks (i.e., equipment, field, trip, method) are often analyzed to quantify artifacts introduced during sampling, transport, or analysis that may affect the accuracy of the data. In addition, the initial and continuing calibration results may be reviewed to verify that the sample concentrations are accurately measured by the analytical instrument.

3.2 Precision

Precision is the level of agreement among repeated measurements of the same characteristic. Data precision or analytical error is assessed by determining the agreement among replicate measurements of the same sample and measurements of duplicate samples, which include MS/MSD samples, laboratory duplicate samples and field duplicate samples. The comparison is made by calculating the relative percent difference (RPD) as given by:

$$\text{RPD (\%)} = \frac{2(S_1 - S_2)}{S_1 + S_2} \times 100$$

where: S_1 = measured sample concentration; and

S_2 = measured duplicate concentration.

3.3 Completeness

Completeness is the percentage of valid measurements or data points obtained, as a proportion of the number of measurements or data points planned for the project. Completeness is affected by such factors as sample bottle breakage and acceptance/non-acceptance of analytical results. Percentage completeness (C) is given by:

$$C(\%) = \frac{V}{P} \times 100$$

where: V = number of valid measurements/data points obtained; and
P = number of measurements/data points planned.

MFG, INC.
DATA EVALUATION CHECKLIST

Project No. : ____

Lab Project Numbers: _____

Sample Numbers or Lab Package Number:

Analytical Methods:

	YES	NO
1. Is a Work Plan, *SAP*, or *QAPP* available?	___	
2. Chain of Custody Records:		
Are the COCs present?	___	
Are the COCs complete and signed off?	___	
Were all samples on the COCs analyzed?	___	
Were any problems noted?	___	
3. Was a project narrative available from the laboratory?	___	
Were any problems noted?	___	
4. Were all holding times met?	___	
5. Was the frequency stated in the Work Plan, SAP or QAPP for field QC samples (duplicates, equipment rinsate, trip blanks) met?	___	

	YES	NO
6. Were all equipment rinsate blank, trip blank, and method blank results ND?	___	
7. Were all matrixes, units, and detection limits reported correctly?	___	
8. Were all surrogate recoveries within control limits?	___	
9. Were all LCS/LCSD spike recoveries and RPDs within control limits?		___
10. Were all MS/MSD spike recoveries and RPDs within control limits?	___	
11. Were all analytical duplicate RPDs within control limits?	___	
12. Were all field duplicate RPDs within control limits?	___	
13. Was the project completeness goal met?	___	

Comments:

Signed:_______________

Date:_________________

APPENDIX B

Well, Pump and Piping System Inspection Procedure for Well 410 (337) J.R. Simplot Don Plant, Pocatello, Idaho

Inspection Date: ____________ Inspectors: ______________________________

____

____

____

A. Start-up and Initial Pump Test

1. Inspect above ground piping, equipment and control panel for improper connections, mis-aligned equipment, wear etc. Repair as necessary and note corrective actions:

____

____

____

2. Start-up system according to the procedure specified in Section 5.2 of the O&M Manual. Record measurements/observations below.

   Initial depth to water: ____________ ft. below measuring point (bmp)

   Note any unusual noises, vibrations or operational problems:

   ____

   ____

   ____

   ____

   Steady flow rate: ____________ gpm

   Steady pressure: ____________ psi

   Depth to water @
   5 min ____________ ft. bmp
   10 min ____________ ft. bmp
   15 min ____________ ft. bmp

   Confirm water is flowing thru the discharge pipe to the collection point at the cooling tower cold pit (note: a portion of this line is underground)
   ______ Yes ______ No

   Note any leaks in the discharge line or other required corrective action:

   ____

   ____

   ____

   ____

   Other comments/observations:

   ____

   ____

   ____

   ____

   ____

Well, Pump and Piping System Inspection Procedure
for Well 410 (337)
J.R. Simplot Don Plant, Pocatello, Idaho

B. Inspect Pump Systems

1. Remove and inspect pump and piping systems. Record observations below.

   Describe scale/precipitate build-up in downhole discharge pipe at pump connection and in pipe segments. Clear or replace piping as necessary. Collect a sample of the build-up and test for chemical and/or biological composition. Field test various acid solutions to determine which is most effective in dissolving build-up. Record comments below.

2. Inspect pump and clean the pump intake screen. Record any comments below.

3. Open the pump and inspect the impellers for scaling and/or wear. Clear any obstructions. Note comments below.

4. Inspect pump motor. Check motor/pump coupling for fouling or wear. Check leads and electrical connectionsfor corrosion. Perform an electrical resistance test on the motor as recommended by the manufacturer. Note comments and test results below.

5. Re-assemble pump and motor.

6. Check the Motor protector ("Motor saver") unit in the control panel. Confirm that the unit is adjusted to the settings listed on Table 4-1 of the O&M manual. Reset as appropriate.

7. Close and open all valves to confirm movement through their full range. These include the sample port ball valve, the gear-operated buttefly valve and the globe valve. Clean/replace valves as necessary. Note actions below.

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C. Inspect and Rehab Well Screen

1. Measure well total depth (T.D) with water level probe.
   Expected T.D. = 161 ft. below ground surface (bgs)
   Actual T.D. = ______ ft. bgs

2. Inspect the well casing and screen with a downhole video camera. Record camera survey on a VHS cassette or other suitable media.

3. Based on the findings of the video camera survey and T.D. measurement, rehab the well screen and/or remove sediments from base of well, as directed. Rehab may include acid treatment or disinfection with surging/swab of screen. Sediment removal may include jetting and pumping. Describe procedure below.

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4. Re-install pump and piping systems. Install a second temporary flow meter downstream of the first flow meter. Start-up pump and check steady flow rate.

   Steady flow rate @ primary flowmeter: ____________ gpm
   Steady flow rate @ secondary flowmeter: ____________ gpm

Difference = ______ %

Replace/repair primary flowmeter if readings differ by more than 10%.
Note repairs, if any.

5. While pump is running, close valve to pressure gauge. Remove existing gauge and install a new gauge. Open valve and compare readings between the two gauges.

   Pressure w/ existing gauge: ______ psi
   Pressure w/ new gauge: ______ psi

   Difference = ______ %

   Leave new gauge installed if values differ by more than 2 psi.
   Note repairs, if any.

6. Compare steady flow rate after rehab with target flow rate. If below target, repeat well screen rehab, as necessary. Summarize results below.

Well, Pump and Piping System Inspection Procedure
for Well 410 (337)
J.R. Simplot Don Plant, Pocatello, Idaho

D. Pump Testing

1. After the well has recovered following well rehab pumping, perform a 4 hour pumping test of well 337. Install pressure transducers in wells 337 and 344 to record the water levels in the wells during pumping and the subsequent recovery period. Use geared-butterfly valve to set discharge rate at 200 gpm for the test.

2. Record flow rate (as measured by the flowmeter) at the following time intervals after pumping starts:

2 minutes	______ gpm	5 minutes	______ gpm	10 minutes	______ gpm
30 minutes	______ gpm	60 minutes	______ gpm	1.5 hours	______ gpm
2 hours	______ gpm	2.5 hours	______ gpm	3 hours	______ gpm
3.5 hours	______ gpm	4 hours	______ gpm	5 hours	______ gpm
6 hours	______ gpm	7 hours	______ gpm	8 hours	______ gpm

3. Record totalizing meter readings:

   Initial (before pumping) ______ gpm Final (after pumping stops) ______ gpm

4. Note observations/comments regarding the pump test below.

Well, Pump and Piping System Inspection Procedure
for Well 338
J.R. Simplot Don Plant, Pocatello, Idaho

Inspection Date: ____________ Inspectors: ______________________________

____

____

____

A. Start-up and Initial Pump Test

1. Inspect above ground piping, equipment and control panel for improper connections, mis-aligned equipment, wear etc. Repair as necessary and note corrective actions:

____

____

____

2. Start-up system according to the procedure specified in Section 5.2 of the O&M Manual. Record measurements/observations below.

Initial depth to water: ____________ ft. below measuring point (bmp)

Note any unusual noises, vibrations or operational problems:

____

____

____

____

Steady flow rate: ____________ gpm

Steady pressure: ____________ psi

Depth to water @
5 min ____________ ft. bmp
10 min ____________ ft. bmp
15 min ____________ ft. bmp

Confirm water is flowing thru the discharge pipe to the collection point at the cooling tower cold pit (note: a portion of this line is underground)
______ Yes ______ No

Note any leaks in the discharge line or other required corrective action:

____

____

____

____

Other comments/observations:

____

____

____

____

____

Well, Pump and Piping System Inspection Procedure
for Well 338
J.R. Simplot Don Plant, Pocatello, Idaho

B. Inspect Pump Systems

1. Remove and inspect pump and piping systems. Record observations below.

   Describe scale/precipitate build-up in downhole discharge pipe at pump connection and in pipe segments. Clear or replace piping as necessary. Collect a sample of the build-up and test for chemical and/or biological composition. Field test various acid solutions to determine which is most effective in dissolving build-up. Record comments below.

2. Inspect pump and clean the pump intake screen. Record any comments below.

3. Open the pump and inspect the impellers for scaling and/or wear. Clear any obstructions. Note comments below.

4. Inspect pump motor. Check motor/pump coupling for fouling or wear. Check leads and electrical connectionsfor corrosion. Perform an electrical resistance test on the motor as recommended by the manufacturer. Note comments and test results below.

5. Re-assemble pump and motor.

6. Store the pump and piping as directed.

7. Close and open all valves to confirm movement through their full range. These include the sample port ball valve, the gear-operated buttefly valve and the globe valve. Clean/replace valves as necessary. Note actions below.

____
____
____
____

C. Inspect and Rehab Well Screen

1. Measure well total depth (T.D) with water level probe.
   Expected T.D. = 81.7 ft. below ground surface (bgs)
   Actual T.D. = ______ ft. bgs

2. Inspect the well casing and screen with a downhole video camera. Record camera survey on a VHS cassette or other suitable media.

Well, Pump and Piping System Inspection Procedure
for Well 343 (401)
J.R. Simplot Don Plant, Pocatello, Idaho

Inspection Date: __________ Inspectors: ______________________________

____

____

____

A. Initial Inspection

Note: Well 343 is currently on-line and pumping at a rate of approximately 60 gpm. The system will be initially inspected while running.

1. Inspect above ground piping, equipment and control panel for improper connections, mis-aligned equipment, wear etc. Repair as necessary and note corrective actions:

____

____

____

2. Measure the well's steady drawdown (via the PVC sounding tube), flow rate and pressure. Record below.

   Depth to water: __________ ft. below measuring point (bmp)

   Steady flow rate: __________ gpm

   Steady pressure: __________ psi

   Note any unusual noises, vibrations or operational problems:

____

____

____

____

3. Confirm water is flowing thru the discharge pipe to the manhole collection point.
   _____ Yes _____ No

   Note any leaks in the discharge line and the condition of the manhole. Perform and note any required corrective action:

____

____

____

____

4. Install a second temporary flow meter downstream of the first flow meter. Check the flow rate readings.

   Flow rate @ primary flowmeter: __________ gpm
   Flow rate @ secondary flowmeter: __________ gpm

   Difference = _____ %

Replace/repair primary flowmeter if readings differ by more than 10%.
Note repairs, if any.

____
____
____
____
____

5. While pump is running, close valve to pressure gauge. Remove existing gauge and install a new gauge. Open valve and compare readings between the two gauges.

   Pressure w/ existing gauge: ______ psi
   Pressure w/ new gauge: ______ psi

   Difference = ______ %

   Leave new gauge installed if values differ by more than 2 psi.
   Note repairs, if any.

   ____
   ____
   ____
   ____

   Record any other comments/observations from the initial inspection:

   ____
   ____
   ____
   ____
   ____
   ____

B. Inspect Pump Systems

1. Shut down the pump according to the procedure specified in the O&M manual. Remove and inspect pump and piping systems. Record observations below.

   Describe scale/precipitate build-up in downhole discharge pipe at pump connection and in pipe segments. Clear or replace piping as necessary. Collect a sample of the build-up and test for chemical and/or biological composition. Field test various acid solutions to determine which is most effective in dissolving build-up. Record comments below.

   ____
   ____
   ____
   ____
   ____
   ____

2. Inspect pump and clean the pump intake screen. Record any comments below.

3. Open the pump and inspect the impellers for scaling and/or wear. Clear any obstructions. Note comments below.

4. Inspect pump motor. Check motor/pump coupling for fouling or wear. Check leads and electrical connections for corrosion. Perform an electrical resistance test on the motor as recommended by the manufacturer. Note comments and test results below.

5. Re-assemble pump and motor.

6. Check the Motor protector ("Motor saver") unit in the control panel. Confirm that the unit is adjusted to the settings listed on Table 4-1 of the O&M manual. Reset as appropriate.

7. Close and open all valves to confirm movement through their full range. These include the sample port ball valve, the pressure gauge ball valve and the globe valve. Clean/replace valves as necessary. Note actions below.

C. Inspect and Rehab Well Screen

1. Measure well total depth (T.D) with water level probe.
   Expected T.D. = 208 ft. below ground surface (bgs)
   Actual T.D. = ______ ft. bgs

2. Inspect the well casing and screen with a downhole video camera. Record camera survey on a VHS cassette or other suitable media.

3. Based on the findings of the video camera survey and T.D. measurement, rehab the well screen and/or remove sediments from base of well, as directed. Rehab may include acid treatment or disinfection with surging/swab of screen. Sediment removal may include jetting and pumping. Describe procedure below.

4. Re-install the pump and piping systems and turn on the pump. Compare steady flow rate after rehab with target flow rate. If below target, repeat well screen rehab, as necessary. Summarize results below.

Well, Pump and Piping System Inspection Procedure
for Well 343 (401)
J.R. Simplot Don Plant, Pocatello, Idaho

D. Pump Testing

1. After the well has recovered following well rehab pumping, perform a 4 hour step pumping test of well 343. Install pressure transducers in wells 343, 307, 308 and 336 to record the water levels in the wells during pumping and the subsequent recovery period. Use globe valve to set discharge rate at 70 gpm (if possible) for the test.

2. Record flow rate (as measured by the flowmeter) at the following time intervals after pumping starts:

2 minutes	______ gpm	5 minutes	______ gpm	10 minutes	______ gpm
30 minutes	______ gpm	60 minutes	______ gpm	1.5 hours	______ gpm
2 hours	______ gpm	2.5 hours	______ gpm	3 hours	______ gpm
3.5 hours	______ gpm	4 hours	______ gpm		

3. Record totalizing meter readings:

   Initial (before pumping) ______ gpm   Final (after pumping stops) ______ gpm

4. Note observations/comments regarding the pump test below.

5,1,2

MFG, Inc.
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consulting
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September 18, 2002

Ms. Linda Meyer (WCM-121)
Project Manager RCRA/Superfund
U.S. EPA Region 10
1200 Sixth Avenue
Seattle, WA 98101

Subject: **Well Inspection, Testing and Installation Program Work Plan In Support of Groundwater Extraction System Design – Simplot Plant Area Eastern Michaud Flats Superfund Site**

Dear Ms. Meyer:

On behalf of the J.R. Simplot Company, please find attached three copies of a work plan for well inspection, testing and installation in support of design of the groundwater extraction system at the Simplot Plant Area of the Eastern Michaud Flats Superfund Site.

Simplot is currently contracting with firms to perform the field work and the target schedule is to begin activities the week of October 14.

Please do not hesitate to call if you have any questions or comments.

Respectfully,
MFG, INC.

Andrew C. Koulermos
Senior Chemical Engineer

C: Doug Tanner - IDEQ Pocatello
Roger Turner - ShoBan Tribe
Ward Wolleson – J.R. Simplot Company (2 copies)

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